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OCTOBER, 1924

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AMERICAN TELEPHONE & TELEGRAPH CO.
NEW YORK

Holders of Rights applying for Stock at the American Telephone and Telegraph Company headquarters

BELL TELEPHONE QUARTERLY

A MEDIUM OF SUGGESTION
AND A RECORD OF PROGRESS

Published quarterly for the Bell System by the American Telephone and Telegraph Company

Subscription, $1.50 per year, in United States and Canada; single copies, 50 cents

Address all communications to
INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

Vol. III | OCTOBER, 1924 | No. 4

A Publicly Owned Institution

From the address of Mr. W. S. Gifford, before the Bell System Educational Conference in New York on August, 18, 1924

THE Bell System is made up of a number of associated telephone companies. In effect, you might consider it as one institution and one company. Due, however, to state laws and different local conditions in the United States, the business is carried on through corporate organizations comprising a parent company, which is the American Telephone and Telegraph Company, a number of associated companies, which do the telephone operating in different sections of the country, and the Western Electric Company, which manufactures telephone equipment and is the supply department of the entire system.

Obviously, our job is to furnish telephone service to the people of the United States. In fact, we are, perhaps, the only institution which by itself has the responsibility of furnishing a nation-wide service of great magnitude. The responsibility for furnishing nation-wide telephone service rests upon us. This is discharged through associated operating companies such as the New York Telephone Company, the New England Telephone Com-

pany, and the Bell Telephone Company of Pennsylvania; and the local and regional services of these companies are connected by the long distance lines of the American Telephone and Telegraph Company. This makes it possible for a telephone subscriber of one company to talk to any of the subscribers of any of the other operating companies. In this way, physically, national telephone service is secured and every telephone is connected with practically every other telephone in the United States.

Now, we do not actually operate, or own, all the telephone business of the United States, although we own two-thirds of it. Substantially the remaining third is owned locally by what we call connecting companies; that is, companies in which we have no financial interest but which connect with our system so that the subscribers of one company can talk to those of any other Bell company anywhere in the country.

There are, it is true, a few places remaining in which there are competing companies. That is, there are a few cities, not many, where there are two telephone systems and where, in order to get complete service, one must subscribe to the service of both companies. It has been recognized by public authorities, and by the public, that two telephone systems are not advantageous to the user; and the process of elimination of competitive situations has been going on and is still going on, and is nearly completed. That means that we have a responsibility not only for a nation-wide service, but also for carrying it on under conditions which are not in the ordinary sense of the word, competitive. So we must, if we are to progress, constantly be on the alert to give good service and to give it at a reasonable cost.

Another way of looking at the furnishing of telephone service would be to say there are three main branches. There is the operating end of the business, such as the operation of the New York Telephone Company; there is the manufacturing of the equipment for the telephone

business, which for the Bell System is handled by the Western Electric Company; and over and above that there is the central administration and the development of the progress of the art, which is undertaken by the American Telephone and Telegraph Company.

The Problems Are Large

Now, the problems with which we deal involve large figures. I do not intend to give you a lot of dry statistics, but I think you ought to know a few of the figures. The total property of the Bell Telephone System amounts to something like two and a half billion dollars. The number of telephones to which we furnish telephone service directly is somewhere between ten and eleven million. In addition, we furnish service indirectly to over four million connecting company telephones. Thus we have some two and a half billion dollars of property devoted to furnishing service through over fifteen million telephones. We have, including the Western Electric Company which is almost entirely engaged in the manufacture and supply of telephone equipment, about three hundred and forty thousand employees, a fairly good sized army engaged in furnishing telephone service.

Moreover, the telephone business differs from a great many other business enterprises in that it grows constantly both in times of business depression and in times of great business activity. It never stops growing. It grows a little faster during times of marked business activity than it does during times of marked business depressions, but it grows all the time. And, the growth of the telephone business requires a constant increase in physical equipment.

It is not exactly like a grocery store which can take care, we will say, of fifty customers, or of one hundred and fifty, or even two hundred and fifty, if the business grows, without building a new store. With us, for almost every new subscriber we take on, we must build a proportional amount of new plant.

It is true that a switchboard will last for a while until the growth fills it up, but when someone who is not a telephone subscriber applies for a telephone, we must wire his house and install his instrument, connect it with the switchboard and, in effect, we must add a pro rata part of a switchboard in order to take care of him. The result is that our construction program, our program for the use of physical materials—building physical plant—runs into very large figures; probably larger figures than that of any other institution in the world.

This year, for instance, we are building plant that will cost $360,000,000. That is our gross construction program for 1924. Some of this is for reconstruction, that is, for replacing equipment that is worn out or is inadequate to serve the needs, but our net construction program this year will involve about $285,000,000.

Careful Planning Necessary

In the planning and development of this construction work, it is quite obvious that the greatest care must be taken that we always adopt the best, that we make no mistakes in our plans, and that we engineer the entire program on sound lines. This is one of the reasons why we have to have so many technical men in this business. The business is a technical and intricate one from the standpoint of construction and operation, and the figures and volume of work done are so large that it provides almost unlimited opportunity for men trained in technical understanding of the electrical art—telephone art, particularly.

We add about seven to eight hundred thousand telephones a year, net, to our system. That is approximately the present rate of growth.

The building of telephone plant lies particularly in the field of technical experts, but there is another problem, connected with a construction program of $360,000,000, that of raising funds to pay for it. Briefly, it means something like two hundred million dollars of new money

every year brought in from investors, large and small, in order to take care of the annual capital requirements of the business. The balance of the program is met by monies obtained from earnings in the shape of depreciation reserves, which take care of the replacement end of the construction budget, and from surplus earnings or undivided profits.

Our financial structure is really quite simple and easily understood. About one-third of our investment, which, as I said, is over $2,500,000,000, comes from money furnished by the stockholders in buying at par, capital stock. Approximately another third of it comes from money which we borrow usually on long term debentures or mortgage bonds, and the remainder comes from the surplus and reserves, to which I referred.

If you bear these things in mind, you will understand one of the apparent mysteries of this business, namely, how it is that with relatively small earnings on our investment, we earn with a margin and pay nine per cent. dividends on our stock. One-third of our investment, as I stated, comes from surplus and reserves, and of course, we do not have to pay any fixed charges on it. Another third comes from borrowed money on which we pay five or five and a half per cent. The other third comes from the sale of stock, and it is quite obvious that if we earn five per cent. on the entire property, we earn about ten per cent. on our stock. So, to pay nine per cent. dividends with a margin we do not have to earn ten or eleven per cent. on our investment, but because of our conservative financial set-up, considerably less than nine per cent. on the property devoted to public service.

Because, therefore, for forty odd years the Bell System has never paid out all that it has earned in dividends, because it has conservatively put a small amount each year (a considerable amount over forty years) back into its properties, we are in the fortunate state of being able to keep telephone rates down to a relatively low level and

still earn enough to enable us to raise this large sum of money annually, to continue to extend and keep up our business and furnish service to those who want it.

A Publicly Owned Business

There is another set of facts of great significance, namely, that the American Telephone and Telegraph Company has about 340,000 stockholders, that some of our associated companies have over two hundred thousand preferred stockholders, and that in addition there are many hundreds of millions of bonds and debentures owned by several hundred thousand individuals and corporations. Our business is one which you may say is publicly owned.

This is one thing I had in mind when I said that business had changed a good deal in the last twenty or thirty years. The ownership has greatly widened. Nobody owns as much as one per cent. of the capital stock of the American Telephone and Telegraph Company. It is not controlled or owned by a small group of wealthy people. It is owned throughout the United States by 340,000 stockholders. Therefore, we have this situation: We have an institution, an American institution, grown up under American laws, plans and ideals, which is really publicly owned, engaged in rendering a public service to the entire country without competition, under public regulation.

We are regulated, and on the whole, we have no complaint whatever, to make with our regulation. Occasionally, and it is what all of you would expect, we have some trouble with regulatory bodies; and, of course, such trouble when it arises occupies the front pages of the newspapers. But we have always welcomed regulation. I believe Mr. Vail was the first man in business to urge publicly and to welcome regulation. We still welcome it. We favor it. We recognize the necessity for it, but we believe that, in some respects, like everything else, it can be improved; and we also believe it will be.

In some parts of the country, we have been raising rates. But, if one stops to think of what has happened to the value of the dollar since the war and compare our increased rates on the basis of a sixty cent dollar with pre-war rates on the basis of a one hundred cent dollar, it will be very clear that, in fact, telephone rates on the whole have gone down.

Everything costs more than it used to cost, and the telephone business cannot live indefinitely in a given locality with a ten per cent. increase in rates, when commodities have increased fifty per cent. in price, wages about one hundred per cent., and the cost of living sixty per cent. The problem we have had as to rates, except in the few cases where they were inadequate to start with, has been merely the adjustment of rates to the changed value of the dollar.

Service the First Consideration

I realize that I have made a somewhat sketchy presentation to you, and it is possible that I have not given you the picture which I wish to leave in your mind. Let me summarize what I have said in this way: Our primary incentive here is to do a good job and to render an effective public service. Of course, we must run the Bell System on a business basis. We must maintain a sound financial structure. For many reasons we must see to it that those who invest their money in the business secure a reasonable return and that the System has satisfactory earnings on its investment. If this were not the case, of course, the business could not proceed—it could not attract the new capital which is necessary in part to furnish the facilities which the people are increasingly demanding. But more money than this, we have no incentive to make. It would not help the business or anybody connected with it for us to attempt to secure abnormal rates. There is no particular person or group of persons in New York or elsewhere, who in any event would be the beneficiary of such rates. As it is, the earnings which are distributed

in the form of dividends go to the 340,000 stockholders of the American Telephone and Telegraph Company and to the several hundred thousand preferred stockholders of associated companies, and these are interested in steady and reasonable returns and in having their stock rated as an investment of high order.

Furnishing ever better and more comprehensive telephone service is the prime incentive to our every day work. More truly, I think, than people outside realize or would credit, we are actuated by the same spirit of enthusiasm in discovering better methods, in rendering a service which will give public satisfaction, and in doing a job well, which animates those working in colleges or scientific institutions. We hope you will realize this fact. If you do, it will enable you to understand many things which we do here, many things which will undoubtedly be brought to your attention during your stay here..

It is our ambition to go on improving the telephone service. It is our ambition to go on lessening the cost of telephone service. It is our ambition to have the respect and confidence of the public and of all the different members and sections of the public. We carry on scientific research on a scale that is probably not equaled by any organization in the country, or in the world. We take as much joy out of discovering new methods and being able to lessen the cost of telephone service as we would in being able to earn a little more money than our competitor, if we were running the ordinary type of competitive business.

We are, in fact, a large, democratic American institution, owned by 340,000 men and women, with 340,000 employees, and $2,500,000,000 of property, all directed toward better and cheaper telephone service for the people of the United States.

The Bell System is really a new sort of thing. It is a publicly owned, privately managed institution, and I hope that while you are here you will catch some of the enthu-

siasm we feel in working in it. I know we shall learn a lot from you.

It is very generous of you to give us your time to come here and help us work on one of our real problems, which is the finding of educated young men who will come in and work shoulder to shoulder with the rest of us in carrying on this great institution.

I welcome you all here. I hope you have a very successful conference and I also hope you will enjoy it and go away with feelings of good will toward us.

Mathematics in Industrial Research

Paper read by Dr. George A. Campbell at the International Mathematical Congress, at Toronto, August 11, 1924

"Selling" Mathematics to the Industries

THE necessity for mathematics in industry was recognized at least three centuries ago when Bacon said: "For many parts of nature can neither be invented [discovered] with sufficient subtility nor demonstrated with sufficient perspicuity nor accommodated unto use with sufficient dexterity without the aid and intervening of mathematics." Since Bacon's time only a very small part of nature has been "accommodated unto use," yet even this has given us such widely useful devices as the heat engine, the telegraph, the telephone, the radio, the airplane and electric power transmission. It is impossible to conceive that any of these devices could have been developed without "the aid and intervening of mathematics." Present day industry is indeed compelled, in its persistent endeavors to meet recognized commercial needs, to make use of mathematics in all of the three ways pointed out by Bacon. The record of industrial research abundantly confirms his assertion that sufficient subtility in discovery, sufficient perspicuity in demonstration, and sufficient dexterity in use can be achieved only with the aid of mathematics.

There is throughout industry one vitally important common characteristic, — uncertainty. In one industry the uncertainty may be due to the supply of raw material, the supply of labor, the supply of brains or the supply of capital. In another industry the uncertainty may be due to the activity of competitors, to fluctuating public demand or to the passage and subsequent interpretations of statutory laws. Still other industries are the playthings of the weather. Whatever the sources of uncertainty it is of vital importance to the industry to reduce to a minimum the hazards due to each of the uncertain-

ties to which it is subjected. To a limited extent hazards may be transferred by means of insurance; but most uncertainties cannot be disposed of in this manner—they must be met by the industry individually.

The practice of probabilities, therefore, has a place in every industry. In fact, it occupies the first place in industrial mathematics, barring only the elementary arithmetical operations. It is remarkable how subtle are the mathematical difficulties presented by apparently innocent problems in the theory of probability. For this reason, mathematicians who are entrusted with the application of probability to industry must have great insight and acumen. Even so, in applying probability to any industry, a beginning should be made with the simpler problems, going on by gradual steps to more and more complicated ones.

Each industry has its own special mathematical problems, which must be considered individually in order to determine where mathematics should be applied. No industrial problem can seem much more hopeless, as a field for exact mathematics, than the subject of electricity as understood in the time of Bacon. It was then a mere collection of curious observations, such as the evanescent attraction of rubbed amber. Persistent observation and careful correlation have, however, brought a large domain of present day electricity under quantitative relations. Electricity is now preeminently a field for mathematics, and all advances in it are primarily through mathematics.

Industrial mathematics will achieve but little unless it is undertaken by persons with suitable aptitudes working under favorable conditions, on problems which have reached the mathematical stage. Industrial mathematical research involves much more than the mechanical application of established mathematical formulas. It involves cooperation in determining the problems to be attacked, in deciding what experimental data are necessary, in ob-

taining these data, in formulating the mathematical problem, in carrying through the analytical and numerical work, in applying the results to the physical actuality and in practically testing the commercial results achieved. In this cooperation many individuals may be involved and many tentative trials may be necessary in order to determine the solution which best meets all of the commercial conditions.

The cooperation must be effective; it must produce results, and these promptly. Mathematical deductions must be made intelligible and convincing, so that they will eventuate in action even when the indications of theory are apparently contrary to practical experience. This is important because the most valuable theoretical results are often revolutionary.

On the part of the industrial mathematician, powers of observation, clear physical concepts, quick resourcefulness, creative imagination and constant persistency are required. These are rare human qualities. Unless industrial mathematical work is made attractive to men possessing these high talents, the full measure of success cannot be expected. Industrial mathematics must offer a career in itself, since specialization is required—specialization of a type which eventually disqualifies most men from undertaking other lines of work most effectively.

Mathematics in Electrical Communication

In order to make the foregoing observations somewhat more specific, I will refer to a few applications of mathematics in the industrial research of the Bell Telephone System. This field is selected because I am more familiar with it than with other industrial activities.

Certainty of prediction is the basic requirement in the development and operation of the telephone system; no vital need of the system can be left to chance or to fortuitous development. For this reason, the Bell System is highly organized under research control. The telephone

situation is studied as a whole; all departments cooperate; each problem is considered from every point of view. Every attempt is made to master a situation in advance of the necessity of action, so that the most effective and economical means for electrical communication may be adopted with each expansion of the system. Much more than the immediate requirements of the hour must be known; preparation for all eventualities must be made. Fortunately, the executives have carried out this program with a prophetic appreciation of the value and necessity of mathematics.

The importance of the theory and practice of probabilities was recognized as soon as the telephone reached a thoroughly commercial basis. It has proved invaluable during the great expansion which has already carried the number of telephones in the city of New York to over a million. Meeting the peak load demand of the million-odd telephones in New York City, on a practically no-delay basis, with the minimum amount of equipment, is a highly complex and important problem. Without probability studies of the situation, the equipment installed at one point would be inadequate, while at other points it would be superabundant. The superfluous equipment would involve a waste of capital, while the inadequate equipment would mean inconvenience to the public and a loss of possible revenue. Equipment engineering involves a large number of probability problems which are novel, difficult, and financially most important. The aggregate cost of all such studies is large, but the resulting saving to the telephone-using public is much greater. Satisfactory telephone service in metropolitan areas is as dependent upon applied probability as is the success of life insurance.

The telephonic ideal, which is the perfect reproduction of speech, with articulation which is indistinguishable from face-to-face conversation, involves extensive and exhaustive investigations in many fields, in particular in

mechanics, acoustics and electromagnetism, since each telephonic conversation involves oscillations in the air, in solids and in the ether. Fortunately, the foundations of the mathematical theory in these three fields had been securely laid by the time Alexander Graham Bell effected their harmonious cooperation in his first telephone. It is impossible for us to be too well informed concerning the consequences of the mathematical laws in these three fields.

It is characteristic of many problems encountered in industry that a great number of independent variables are involved, far too great a number for the best solution to be reached simply by trained judgment. Consider the transposition problem of the telephone system, which is this: on pole lines, long lines between cities, for example, several wires—sometimes a great number of wires—are strung along in close proximity. Each pair of wires receives inductive effects from the electric waves carried by every other pair, producing so-called crosstalk. To reduce such effects, the pairs of wires are transposed according to a set plan; that is, the positions of the two wires are interchanged, an expedient analogous to the twisting of a pair of wires. It is necessary to consider not only the ideal location of the transpositions in each pair of wires, but also the practical irregularities which occur in the actual placing of the transpositions. One of the practical problems, in fact, is to determine the allowable tolerances limiting the irregularities in the location of loading coils and transpositions, since these irregularities modify the crosstalk and also the transmission efficiency by an amount which must be determined by the laws of probability.

Transpositions were originally introduced with complete success about thirty years ago, and yet at the present time this subject is being more actively studied than ever; this is due to the extended use of phantom circuits and the new uses of carrier frequencies, that is, high-frequency speech carrying currents which are superposed on ordinary telephony.

To illustrate the way in which problems in industrial mathematics become, step by step, more complex by the progressive inclusion of one factor after another, brief reference may be made to the loaded cable circuit. The first successful telephone cable circuits could be treated mathematically on the basis of Kelvin's simple cable diffusion theory. To allow for the ignored inductance and to determine the effect of added inductance, Heaviside's much more complete transmission formulas were employed somewhat later. The next stage was to allow for the effect of inductance which was not uniformly distributed, but lumped at regular intervals. Here the steady state solution for sinusoidal vibrations of a loaded string was employed, and the cutoff frequency due to internal reflections at the loading coils determined. But with loaded cables of great length, extending from New York to Chicago and beyond, the transient state may be of such duration as to require consideration. The loaded line does not transmit the impulse as a whole, but breaks it up by reflection and transmission at each loading coil. Therefore some of the impulses arrive after a few short backward reflections, while other impulses may travel many times the length of the line, due to reflections back and forth at many of the thousand loading coils in the circuit. The calculation of the transient state at the receiving end, due to the arrival of these impulses in groups, one after another, involved the calculation of Bessel functions up to order 2000 and subsequent integration by an application of the principle of stationary phase to Fourier's integral.

Industrial Mathematics as a Career

It is true that the mathematician who takes up industrial work is not entirely free to set his own problems; the industry which he has chosen provides these and it demands concentration upon them. Such problems are often less inviting than the clear-cut, tractable problem which the pure mathematician is at liberty to set himself.

Industrial problems may be most complicated to frame and they may admit only of approximate solution by laborious numerical methods. In addition to delimiting the nature of his problems, the imperative needs of industry set time limits for their solution, and the nature of industry demands a financial profit from industrial mathematics. But these restrictions of industry should not make the work less attractive. On the contrary, restrictions disclose the master. There is an inspiration in overcoming even the humblest difficulty standing in the path of progress. Restrictions, even in the case of the most gifted, may be beneficial in concentrating activities, thereby making up in depth what may seem lacking in breadth.

The industrial mathematician may have a chance to attack many large-scale investigations which would be impossible, except under the patronage of industry, because of the exceptional material equipment and widely sustained cooperation required. Some of the opportunities offered by cheap electrical power from Niagara, by high-voltage electric power lines, and by large steam turbines may be mentioned. It is often left to the industrial mathematician to reap the harvest from seed sown under adverse circumstances by pure mathematicians.

The industrial mathematician may hope to make some return for the debt which he owes the pure mathematician. He may introduce new mathematical problems, of which industry is an inexhaustible source. He may point out the application of pure mathematical results, stimulating further investigations along the same lines. He may assist mathematicians generally by promoting the preparation of needed tables and by creating a commercial demand for calculating machines and other brain-saving devices.

The opportunities presented by industrial mathematics are boundless, because mathematics is the key to extrapolation in time, and industry is absolutely dependent

upon prediction. The position of mathematicians in industry must eventually correspond with the importance of the function which they may perform.

Training for Industrial Mathematics

In industry we are concerned with mathematics not as an objective, but only as a tool. It follows that the required training in mathematics should develop a wide acquaintance with the available mathematical tools and practical skill in their use. It is important to note the distinction between the using of tools and the making of tools. Under primitive conditions the workman makes his own tools, but in a highly organized society the tools are made by specialists, who provide the workman with an endless variety of implements superior to anything which he himself could make. By long experience the tool designer has discovered how best to adapt the tool to its intended use in order to economize the workman's time and energy as much as possible. Furthermore, the substitution of one tool for another with the minimum number of motions is made possible by the use of interchangeable parts and systematically arranged cabinets.

But no complete line of mathematical tools is for sale across the counter; only a limited number of numerical and algebraic tables and a few types of calculating machines are supplied as ready-made tools. By far the larger part of known mathematical tools must be sought for in the literature of the subject, but there they may be difficult to find and isolate in the form best adapted for the purpose in hand. What is very greatly needed at the present time is a compendium or unabridged dictionary of mathematical results concisely and uniformly stated, and systematically classified for convenient reference. What I have in mind is not a mere handbook of applied mathematics, but a statement of theorems and formulas and tabulated results expressed in the language of pure mathematics, and comparable in scope and size with the

"Encyklopädie der Mathematischen Wissenschaften." Preparation of such a compendium would be a tremendous undertaking, but it would also be of the greatest value. To such a collection of tools the industrial mathematician would turn for the appropriate tool as each new problem arises.

I would have the university training of the industrial mathematician based upon such a compendium by means of judicious sampling, at many points, under competent leadership. He would thus become familiar with his source book as a whole and thereafter turn to it instinctively and use it with confidence. At the present time, when the average text-book is held in low esteem and nothing has been substituted which adequately fills the gap, the student of mathematics leaves the university with a five-foot shelf of notebooks, together with what he carries in his head. Neither the memory nor the notebook is likely to be a reliable source of information when a particular result is needed for the first time, ten years later. It then becomes necessary for him to take the time to deduce the result from first principles, or to hunt up lecture notes, a text-book or original paper and waste much valuable time picking up the thread of the argument. The sampling to which I have referred should not be that of a dilletante; it should be an intensive grounding in the fundamental concepts and methods of mathematics, and the development *ab initio* of several well distributed branches of mathematics.

The combination of mathematical ability with an observant mind is as desirable as it is rare. The university training should include non-mathematical courses adapted for developing the powers of observation, or at least an appreciation of the necessity of cooperating with others who are observant. A study of the natural sciences, accompanied by experimental work, should be of great value. It is, of course, difficult to be reasonable and not ask the impossible of the university in the training of any spe-

cialist. We recognize that, at best, only a beginning can be made at the university, but this beginning should include the fundamentals and should not attempt to impart details of current industrial practice. These details are best acquired in the industrial environment itself. Self-training in fundamentals, on the other hand, is much more difficult, and is not likely to go far, unless a start has been made under the favorable conditions afforded by the university.

What I have tried to emphasize is that industry can realize its greatest possibilities only with the aid of mathematicians, and that mathematicians can find opportunities in industry worthy of their powers, however great those powers may be. To ensure the success of industrial mathematics the industry must inaugurate mathematical research as early as possible, so that ample time may be afforded for the gradual accumulation of information upon which mathematics may be securely based, and for deriving quantitative results before the necessity for commercial action arrives. The industrialist must also be ready to give the mathematician's conclusions a sympathetic trial even though they run contrary to established precedent. Above all, industry needs mathematicians of an especially broad type—men whose interests naturally extend beyond their special field, and who are flexible enough to cooperate with non-mathematicians. These industrial mathematicians must inspire confidence by their firm grasp of physical realities, by the relevance of their mathematics, and by the ability to present their results clearly and convincingly.

GEORGE A. CAMPBELL.

The Statistical Study of General Business Conditions

THE business of the Bell telephone companies is one of unusual stability. Year after year, in good times and bad, the operations of the Bell System show steady expansion. But this relative stability of the telephone business does not mean that the business is in no way affected by changes in general economic conditions. Fluctuations in industrial activity, as a matter of fact, have a definite influence upon various elements of telephone revenues and expenses, as all telephone men know; and it is for this reason that telephone companies are, and must be, interested in the study of general business conditions and, specifically, the study of the cyclical fluctuations of business activity. It is with the character and importance of this study that the present article is concerned.

The Nature of Cyclical Fluctuations in Business Activity

In introduction, a word as to the nature of cyclical fluctuations of business activity, based upon an example from recent industrial history, may not be amiss. Many economic statisticians have come to the conclusion that, taking conditions throughout the United States as a whole, the summer of 1924 witnessed the end of one business cycle and the beginning of another The cycle just completed, in the view of these statisticians, covered a period of about three years. It began in the summer of 1921 with the upturn from the severe depression of 1920–21. Business activity gained impetus through 1922 and reached its high point in the spring of 1923. Subsequent to this came a decline in business and in industrial activity. With an interruption last winter, the decline continued until this past summer, by which time business in general had fallen off to a point where it might fairly be described as depressed. The cycle, then, was char-

acterized by the usual sequence of revival or recovery, prosperity, liquidation or declining activity, and depression. An index of fluctuations in industrial activity, related to estimated "normal," for the five years 1919–1923, is shown on Chart No. 1.

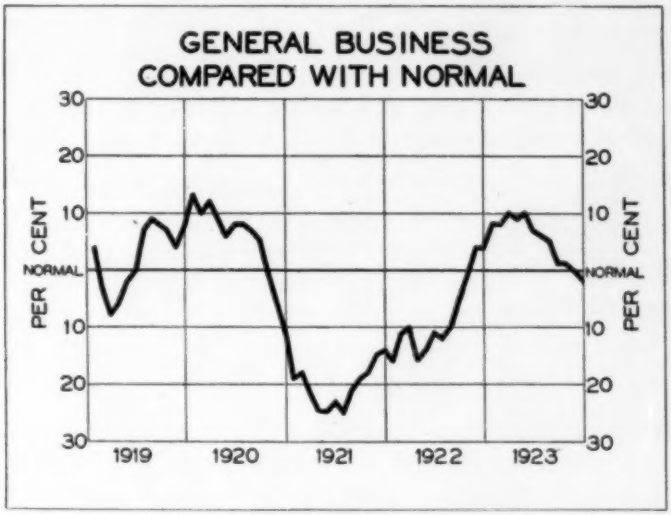


Chart No. 1

To say that the business cycle through which we have just passed had certain unusual features is only to particularize from the generalization that no two business cycles precisely resemble each other, either as to duration of the cycle or of its several phases, the amplitude of the business fluctuations involved, the exact sequence of cause and effect, the predominance of certain causes, or the absence or presence of other characteristics. To some persons this lack of uniformity proves that there is no such thing as a business cycle. It is fair to say, however, that to the majority of economic statisticians the divergent characteristics of individual cycles indicate merely that the business cycle is like any other composite result of a large number of forces, both human and inanimate, acting with different intensity and in different

directions at different times. Common business experience and statistical analysis both indicate beyond a doubt that business moves in waves or tides. No two ocean tides are precisely alike, and neither are any two business cycles. Ocean tides are the response of the ocean to the gravitational pull of the moon; business cycles are primarily and essentially adjustments of production to consumption, responding to the pulls of prices and profits.

Three Types of Studies of Business Conditions

Studies of nation-wide or regional business conditions, apart from the study of the conditions of individual enterprises, are of three types: (1) The gathering of opinions from business men, bankers, credit agencies, or other sources as to "how things are going;" (2) personal observation of developments supplemented by deductions from such raw statistics of business activity as bank clearings, freight car loadings, pig iron production, and exports and imports; and (3) mathematical analysis of significant statistics supplemented and interpreted by economic knowledge and judgment.

The first of these methods certainly has the merit of ease and simplicity, and for a small business or for the purpose of solving specific problems or securing information on specific situations, it may be of very substantial value. For a business as large and complicated as the telephone industry, however, it lacks adequacy, clearly lacks reliability, and too often reflects subjective impressions rather than facts. The second method is hardly better, as it is hoped later portions of this article will show; and indeed it may prove even less adequate than the securing of intelligent opinion from a number of outside sources. The third method has at least the merit of approaching as near to exact scientific inductive methods as is possible in the field of applied economics, and further may fairly be said to have "proved in" in cases in which it has been employed.

The fact that the fluctuations of business—call them cycles or what you will—are not subject to precise measurement and are not as predictable as tides, instead of making statistical analysis of economic conditions worthless, renders it all the more important. But it is not the purpose of this article to propound a theory of business cycles, on the one hand, or, on the other, to expound or evaluate various methods of statistical analysis of business conditions. What it will seek to do is, first, to point to what is the essential job of the business economist; second, to indicate in a very general way the method of statistical approach to this job and the need for proper selection of statistical data; third, to illustrate the aid which statistical analysis can give in the selection of the useful data for business studies and in the interpretation of business fluctuations; and, finally, to suggest the extension of the statistical study of business conditions in the Bell System. First, then, to ask, what is the nature of economic activity, and what is the job of the business economist.

The Job of the Business Economist

All economic activity consists of endeavors to take cognizance and advantage of margins or differentials, objective or subjective. Profits, in the business man's use of the term, are differentials between costs and selling prices. Savings by the individual or the community represent margins between production or income, on the one hand, and consumption or expenses or outgo, on the other. Consumers' choices are dictated by differentials of satisfaction or utility: shall I spend or save and invest a hundred dollars I have, and if I spend it, shall it go for clothes, or a radio set, or books on egyptology, or a motor trip, of none of which I happen to be badly in need? My choice will depend on my estimate of which use or uses of the money will give me the maximum net satisfaction, present and future. One piece of land rents for twice as much as another because it is expected to yield a

differential of one sort or another which warrants it—always assuming free competition and choice among the parties concerned. Now if differentials could always be gauged and estimated correctly, and (in the case of those measured pecuniarily), objectively, and if these correct estimates could be acted upon freely and adjustments made without friction or delay, there would presumably be no business cycles as such. Wide fluctuations in business, except such as are due to catastrophes like wars or to other "accidental" factors, are reflections of misjudgments about margins by groups of producers and consumers. Mass action causes these misjudgments to accumulate until toward the end of a period of prosperity many producers' costs mount above probable selling prices, creditors' risks overbalance probable gains, difficulties of hiring and keeping the right personnel and of securing transportation service for the shipment of goods cause delays which are fatal to profits and cause unbalanced inventories to pile up, and other sorts of friction impede business operations; while by the end of a period of depression, prices have been slashed and severe losses taken, plant is idle, laborers are idle, bank funds are idle, and for most concerns only overhead is working overtime. Yet at every single moment of time business men are making choices and taking risks, acting on their knowledge or their notions of differentials, perhaps making millions, perhaps only making the best of a bad bargain. In essence, the job of the business economist is to observe what is happening to differentials in industry and trade, and to interpret the effects of the developments that are taking place. In this work statistical studies are of the greatest value.

The Statistical Approach to the Study of Business Conditions

The statistical study of business conditions—like most other statistical work, including the "peg count" of traffic in the telephone industry—involves the use of

sampling methods and is in the first instance a matter of proper selection of representative and significant data. This is true for a number of important reasons. In the first place, apart from everything else, statistics are not available which would make possible a completely comprehensive picture of all aspects of business conditions. In the second place, as in so much other statistical work where the figures deal with large masses of data, intelligent sampling can give fairly adequate representation of the significant facts, expecially since for any particular purpose in view, many groups of statistics would have little or no significance.

There is a third factor which makes sampling necessary. The different timings of the fluctuations in various industries, the varying intensities of these fluctuations, the relative importance of the industries in the business life of the country—these are only a few of the many factors which cause widely varying significance and utility in different groups of statistics, even within the single field of production. Then there are all the other phases and results of economic activity, including domestic distribution of goods in its various aspects, banking and credit operations and relationships, employment, wages, prices, international trade, and so on—all embodying operations or results that are statistically measurable with more or less precision and that are therefore possible, though they are not all equally profitable, subjects for statistical analysis. Finally, there is the factor that in the study of business cycles, as has been noted, statistical analysis must interest itself largely in margins, or differentials, especially to the extent that such analysis is to have utility in forecasting probable changes in business activity. One of the important criteria in selecting data which shall show how business is going is the relative sensitiveness with which the data respond to changing differentials that reflect fundamental changes in the conditions under which business enterprises are operating.

The charts that follow, covering by months the years 1919–1923, inclusive, illustrate this and show the importance of proper analysis and selection and of correct interpretation of economic data.

Varying Types of Fluctuations in Industry, Trade and Prices

Even if there were no marked booms and depressions, the character of consumption and the proportions of goods or services required year by year would change, not only because whole new industries like the telephone, the radio and the automobile come into existence, but because fashions of every sort change and also because it is so easy to defer some types of demand or consumption to satisfy others. Different industries respond utterly differently to changing demands. So large a part of the output of crude petroleum, for example, is turned out at liberal profits, and under fortuitous conditions of production and intensively competitive exploitation of oil-bearing areas, that production of that product is relatively insensitive to changes in business conditions, and it is mainly through price rather than production changes that the business cycle has its effects. The highly competitive textile industry, on the other hand, working for the most part on relatively small margins, with no direct control of its supply of raw materials, and producing semi-durable goods, responds for various reasons rapidly and sharply to cyclical changes; the condition in regard to differentials is almost at the opposite pole from the oil industry. In iron and steel, we have a highly integrated industry producing durable goods used almost entirely in producing other goods or services. Last year, about five-eighths of its products went to four industries—railroads, building construction, automobiles, and the oil industry—the first three of which characteristically show wide fluctuations in their demands for iron and steel products. Production of pig iron therefore also fluctuates greatly, in spite of the high degree of

integration of the industry, chiefly as an indirect effect of developments in other industries. Chart No. 2 indicates graphically the different contours of activity in these three industries—oil, textiles, and iron and steel—

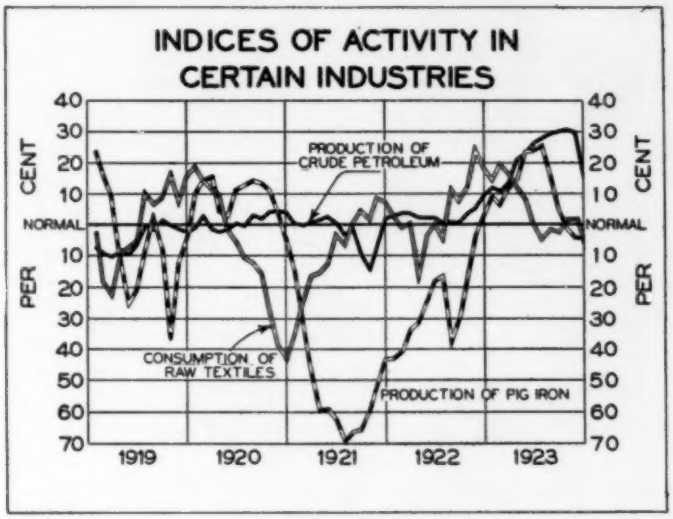


Chart No. 2

during the five years 1919-1923. A comparison of the chart with Chart No. 1 is of interest as showing how the variations in productive activity in those industries tuned in with the fluctuations in general industrial activity.

So much for operations in three producing industries, one turning out almost entirely producers' goods, one largely consumers' goods, and the third, oil, with final products whose use it would be hard to apportion between producers and ultimate consumers. In the movement of goods to buyers, the railroads play the principal role, and as a result such series of figures as those showing freight car loadings and net ton mileage of freight moved have been considered good indices of general trade and business conditions. Car loading figures are issued weekly and never fail to draw comment from financial

writers in newspapers, as to their real or assumed significance. Chart No. 3 shows on a logarithmic or ratio scale, the movements of three types of revenue freight as indicated by monthly car loading figures for Class I

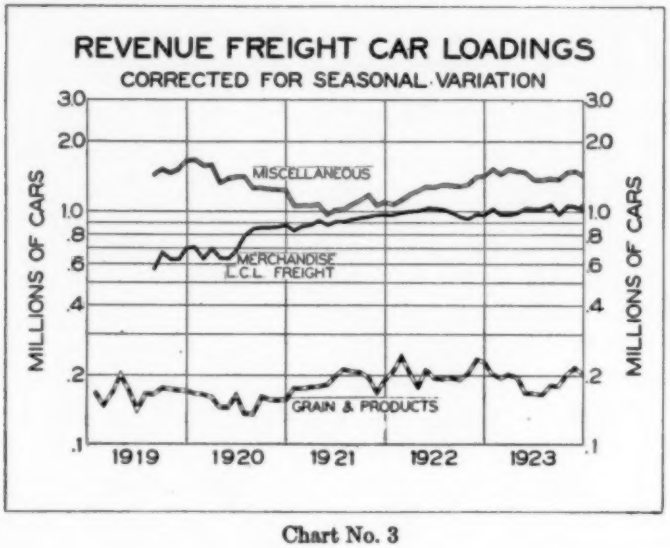


Chart No. 3

railroads, corrected for seasonal variation. Only one of the curves, that of miscellaneous freight, shows any resemblance to the curve of industrial activity on Chart No. 1. This is miscellaneous freight in carload lots, freight which does not fall into other classifications, such as forest products, ore, coal and coke, grain and grain products, and so on. Less-than-carload (L. C. L.) freight not only shows no influence of the remarkably wide fluctuations in business during the period covered, but, nearly doubling as it does in four years, does not clearly reflect motor truck competition. The movement of grain and grain products, as shown in the bottom curve on the chart, clearly gives no clue whatever either to business conditions or to the agricultural distress of the last few years.

We turn now to the fluctuations in retail trade. Chart

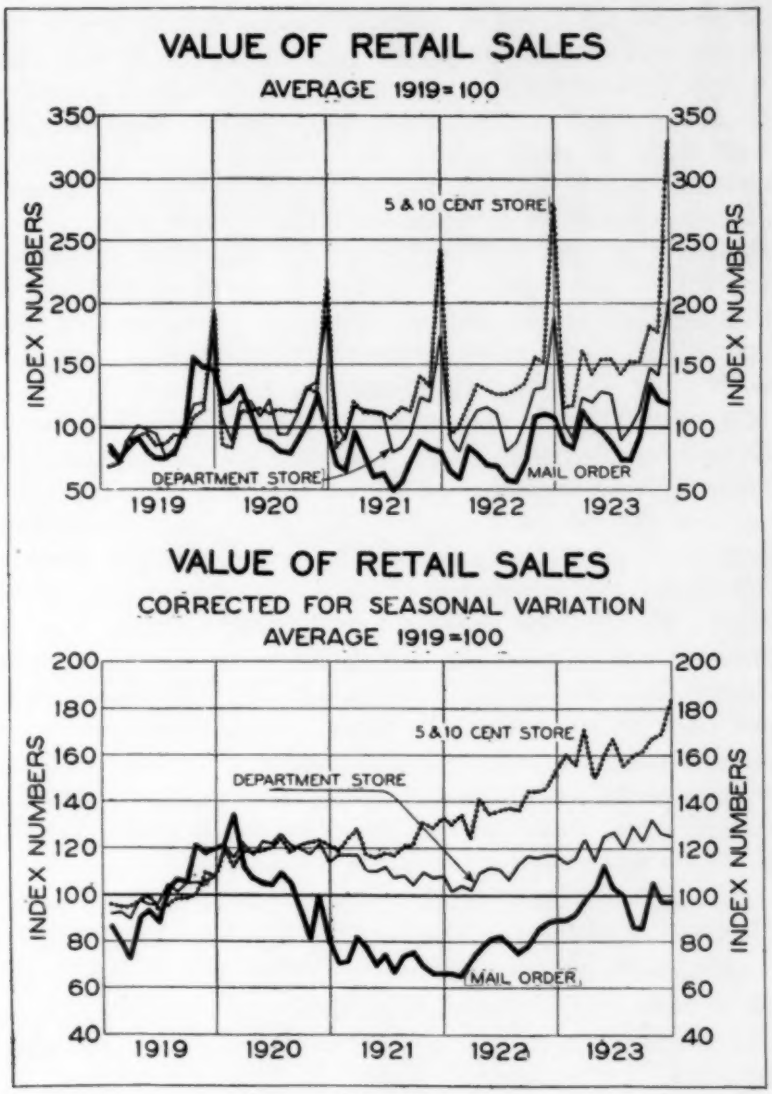


Chart No. 4

No. 4, based on figures compiled by the Federal Reserve Board, indicates the changes in the money value of sales by groups of department stores, mail order houses, and 5 and 10-cent store chains, respectively, for the five years

1919-1923. Paying no attention for the moment to the upper half of the chart, let us examine the lower half, which represents the correction for seasonal variation of the data on which the upper half is based. (No correction is shown here to allow for price changes, so as to transform value figures into sales volume figures.) Here again are three quite different curves, which, even though they portray only partially analyzed statistics, tell interesting stories as to the types of fluctuation in this field. The department stores are in cities, and the curve for their sales resembles considerably, though with a lag, the curve on Chart No. 1 and also the curve (not reproduced in this article) which shows the fluctuations in employment in New York State factories. The curve of mail order sales shows the effect of low agricultural prices on the sales of houses which depend largely on rural business, and indicates a much greater fall during the depression of 1921 than department store sales. Finally, the sales of 5 and 10-cent stores show a phenomenal increase in the five years shown by the chart. No attempt will be made here to carry this analysis further; rather the moral will simply be pointed that, lacking further analysis, any one of these curves, or even all three, would give a far from adequate indication of what was happening to the trade and business of the country during the years 1919-1923.

Finally, in the field of foreign trade, Chart No. 5 offers an interesting comparison between the movements of two groups of commodities—imports of crude materials and exports of manufactured goods ready for consumption. The original value data, corrected only for seasonal variation, are presented here; again no correction is made for price changes. The most striking thing about the chart is the close resemblance of the curve of imports of crude materials to the curve on Chart No. 1, the former actually preceding and seeming to forecast the latter. A curve of shipments or output of manufac-

tured merchandise naturally should lag after one of production or imports of raw materials; and the export curve on Chart No. 5 lags definitely after the import curve and after the curve of general industrial activity.

Chart No. 5

But what is equally interesting is that the curve of exports of manufactures gives little clue to the turning points of business activity in this country, or to the world-wide economic unsettlement of the last few years. To those to whom prosperity through foreign trade means keeping out imports and pushing out exports, the chart must be rather disappointing. It seems to show that active business comes, partly at least, only by the help of imports from abroad and that large orders from aboard for American manufactures at best accompany, rather than precede and cause, active business at home. The chart therefore once more indicates the very limited usefulness of raw or only partly analyzed business statistics.

So much to indicate some of the divergent types of fluctuations within the fields of production and trade.

A simple chart will illustrate differences in price movements in the business cycle. Chart No. 6 shows index numbers of wholesale prices of three commodities—zinc, pork, and steel rails. The movements of these

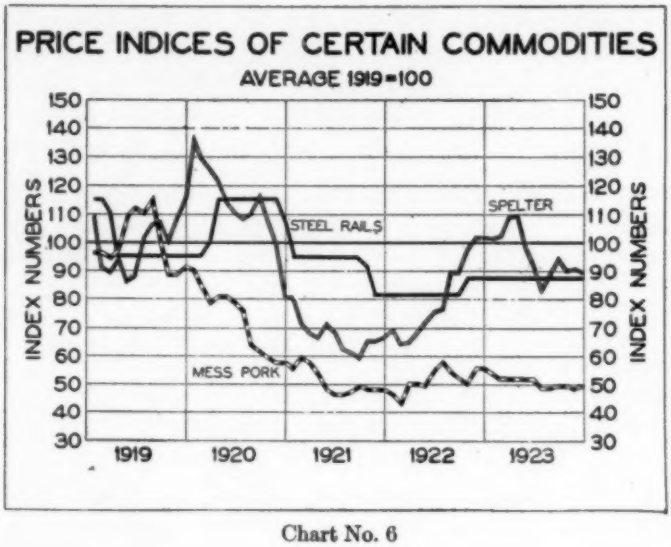


Chart No. 6

prices differ widely. In the zinc curve we find a marked family resemblance to the curve on Chart No. 1 and the other graphs that have been noted as resembling that curve. Before the war, the price of mess pork, as Professor W. M. Persons of Harvard has shown, tended to move sensitively with the business cycle; but the chart shows that during the last five years, aside from experiencing a big drop in prices with almost all other commodities, it has not responded as have prices of zinc and some other commodities to business changes. The price trend of pork was downward throughout most of the five years shown on the chart, for reasons which need not be discussed here. Steel rail prices have moved almost in direct opposition to industrial activity, falling just as business was picking up in the spring of 1919, advancing after general business had

reached its peak relative to normal early in 1920, and dropping to the low point for the five years shown, after business recovery had begun in 1921. This lagging characteristic and the maintenance of fixed prices for months at a time or even a year or more, afford a sharp contrast with the price sensitiveness of pig iron and of some of the other products of the iron and steel industry, and indicate clearly the tardiness of some of the adjustments of industry to changing conditions and differentials.

Importance of Selection and Analysis of Data

It is hoped that the foregoing charts and the brief comments thereon have served to illustrate in simple fashion and to emphasize some of the varying ways in which different types of business activity adjust themselves to changing economic forces and differentials. The economic statistician, out of the mass of available business data, must, as was said a few pages back, select those data and indices which will give him the greatest assistance in interpreting the conditions in which he is interested, and, by the same token, he must reject those which are relatively or absolutely useless for his purpose. Probably it is correct to say that no series of figures has utility for all purposes. Statistics that would throw the greatest amount of light on merchandising problems in the 5 and 10 cent store business may be quite useless for guiding manufacturing or price policies in steel rail mills. Nor can intelligent selection of data be finally made until those data have been analyzed. To return to Chart No. 4, we find in the one field of retail trade three statistical series which illustrate well some of the factors involved in this analysis. The upper half of the chart shows actual sales in the form of index numbers related to average monthly sales in 1919, but not adjusted in any other way. The large seasonal factor in the business of all three types of stores, and especially in the 5 and 10 cent stores, is too apparent to

require comment. The Christmas rush affects the volume of business in department stores less than in the 5 and 10 cent stores; while for the mail order houses the annual peak of business comes not in December at all, but in October or November. There are few statistical series which do not exhibit fairly characteristic seasonal variations, even though most of them be not as pronounced as that in 5 and 10 cent store sales.

Now, looking at Chart No. 4 as a whole, we note clearly the differences between the three curves not only in their response to the seasons and to the business cycle, but in the long-term trends of the figures. In the 5 and 10 cent store business, seasonal and trend factors are so important that in comparison with them cyclical factors are relatively unimportant. In the matter of trend the business reminds us of petroleum output, alluded to above. Contrasted with this is the mail order business, where seasonal factors count for much less and where there is no steep upward trend, so that cyclical changes, at least during the five-year period shown, are of great importance. The department store business is found in between the other two in regard to these matters. This simple illustration points clearly to the necessity for analyzing current statistics, if the statistician is to make valid comparisons either within or without his own industry.

Conclusion

The changes wrought in the last ten years by the war and by the subsequent economic unsettlement have made intelligent detailed study of business conditions more necessary than ever before in the successful conduct of industrial and commercial enterprises. Over the next few years the problems of the average business organization in the United States will certainly not be made easier by economic developments in Europe. Statistical study of business conditions will therefore become increasingly necessary and profitable. Fortu-

nately, an increasing volume of statistical data throwing light on business conditions is becoming available, and along with this, more nearly perfect methods of statistical analysis are being devised to handle the data. Economic research work generally, both statistical and other, is proceeding apace and giving increasing aid to business executives and students.

It is hoped that the preceding pages have shown that the intelligent use of statistical tools in the study of business conditions requires craftsmanship, just as does the proper use of tools in any other art. We may conclude, for example, even on the basis of the inadequate exposition of this article, that there is no peculiar merit in any single statistical index, or any composite index of business conditions, unless it is found to suit the particular job in hand; nor is there of necessity demerit in any other index. Further, it is just as superstitious merely to wave a mathematical wand over economic statistics and expect useful results for executive purposes, as reliance on wand-waving or on charms generally is. There are too many factors, too many differentials that are not statistically measurable or statistically predictable, for any such simple process as that. What is the practical end or aim of statistical study of business conditions? Surely it is chiefly to enable intelligent planning of future operations. Now forecasting, in any sphere, is merely a reasoned estimate of the future effects of observed and observable facts and tendencies. Statistical analysis is an absolutely essential aid to intelligent interpretation of available business data; but the selection of the significant data, the estimating of the relative importance of trends as against short-term factors, of money market factors and political conditions, of labor costs and price tendencies, of surplus capacity or potential overproduction problems for raw material industries, such as oil or copper or wheat, or for manufacturing industries like automobiles or tires—

these require something besides the collection and mathematical analysis of even the most pertinent data.

Few industries have made more use of internal and external business statistics than the telephone industry and, specifically, the Bell System. Few have greater need for such statistics as an aid to intelligent planning of short-term and long-term operations. The work that has already been done has proved the feasibility of relating fluctuations in telephone operating factors, such as traffic, revenue, and station gains, to indices of business conditions by methods of statistical analysis. Most, though not all, of this correlating work has related to past performances by way of explaining what has happened.

Although a considerable degree of progress has already been made, much still remains to be done by the Bell System in the field of business studies. The general staff of the American Telephone and Telegraph Company, through the studies of the economic statistics section of the Chief Statistician's Division, has for some years been engaged in the statistical study of general business conditions on a nation-wide basis. The work of the American Company, it is believed, should now gradually be supplemented by an increasing amount of similar work on the part of Associated Companies, covering conditions in their respective territories. It is not true, and it would not be sufficient to depend on it, if it were true, that business tides in this country move regularly from east to west. There are always sufficient differences both in the present situations and in the outlook in the various regions of the country in which the Associated Companies operate, to warrant closer and more adequate regional studies of business conditions.

F. E. Richter.

Communication Engineering and Electrical Curricula

RECENT years have seen a rapidly growing appreciation of the technical problems of the communication art by the engineering profession generally, and this has been reflected in the form of many inquiries to the Bell System from engineering faculties concerning ways and means for using the subject matter of electrical communication in their teaching.

In making recommendations regarding the subject matter of electrical instruction it is essential to recognize first the general purpose of that instruction. The qualities needed by the college man for success in industry are the same as those needed by the non-college man. Easy to name but proverbially hard to develop by direct training, these qualities include such traits as industry, reliability, initiative, good observation, imagination and judgment, and the ability to learn and to cooperate with others. In addition the graduate ought to possess, when leaving college, a working knowledge of the sciences underlying the industry he intends to choose.

What the relative value of a graduate's knowledge in distinction to his mental qualities is, it is not necessary here to state definitely, nor could an entirely satisfactory formula probably be found. The essential point is that college instruction should be designed both to train the mind in useful ways and to impart a thorough knowledge of the underlying and permanent fundamentals, leaving to the job the inculcation of whatever knowledge of its specific practices may be necessary.

The purpose of this article is to discuss the art of electrical communication and its relation to electrical curricula from this point of view, indicating wherein its instructional and pedagogic value seem to lie, and also to outline briefly the opportunities which the communication field offers college graduates.

Communication and Power Engineering Contrasted

Since most of the present day electrical engineering courses are founded upon the technique of the electric power industry it will be well to begin by recalling to mind certain underlying differences between the problems of the power engineer and the communication engineer.

In a very fundamental sense the difference between the two arts is one of numbers. The power engineer is concerned with a few units of great size, the telephone engineer with an enormous number of units of moderate size. The former fixes his attention on a single frequency, the latter on a broad electrical spectrum extending from zero to millions of cycles per second. The former sets his connections up for long periods of time; the latter must provide through his central offices and switchboards for the making and unmaking of his connections at the rate of about 40 millions per day. This involves extensive signalling equipment. It also gives scope for almost unlimited probability and statistical research in order that the connections be set up as required with the use of a minimum of apparatus. The power engineer thinks of his main distributing lines as for the most part electrically short and not inductively related; the telephone engineer has closely packed lines most of which are electrically very long, paralleling one another and transmitting such frequencies that unique and intricate problems of crosstalk, reflection and transients arise. His circuits also parallel power lines and the resulting inductive interference requires that the matter of transpositions be carefully studied.

Because of the rapid switching which the operation of telephone lines requires, the telephone engineer has the problems attendant upon the employment, training and direction of large corps of operators. While both engineers are public servants, the power man has only to consider contact with the public at intervals of starting and discontinuing service, whereas the telephone man,

directly or indirectly, comes in contact with each of his subscribers on the average of about five times every day. The result is that the element of public relations is intimately woven into all telephone problems. The difference of numbers also runs through the manufacturing aspects of these two fields of engineering. In addition, telephony involves a wide range of problems, peculiar to it alone, which touch many fields of science such as chemistry, metallurgy and acoustics.

From the foregoing, it will be apparent that the scope of communication engineering, and even that portion of it usually designated as telephone engineering, is extremely broad. Not since the early days has any one person been able to familiarize himself with all its branches.

Today there are many different kinds of telephone engineers, ranging from the research expert developing new devices in the laboratory to the commercial engineer engaged in population surveys and formulating estimates as to the trend and growth of various industries so as to foretell their effect on population growth and concentration. There are traffic engineers, charged with the operation of the 45,000,000 mile network of wires covering the country, who must study the conditions under which circuits are used and how best to adapt them to the varying loads; find improved ways of dispatching traffic, and measure and improve the accuracy with which it is handled. There are plant engineers concerned with the installation and maintenance of the physical property of the Bell System which now represents an investment of two billion dollars. There are the manufacturing engineers who must both steadily improve the quality and reduce the cost of making the present designs of apparatus and develop satisfactory processes for making new types. There are development engineers who must work in close cooperation with the plant and traffic people on the one hand to ascertain their practical needs

and with the research laboratory on the other to see that full advantage is taken of its developments and discoveries.

The Broadening of Electrical Curricula

The mechanical and electrical problems which arise in telephone engineering from the use of a wide range of frequencies and circuits which are complex, because of their great electrical length, their inductive interrelations, and the number of services which a single pair of wires is required to render, emphasize the fundamental importance of the sciences of physics and mathematics. In addition, the problems have the economic aspects which constitute such an important factor in all engineering problems, and which in large measure differentiate the work of the engineer from that of the scientist.

Communication engineering therefore furnishes a basis for broadening electrical engineering instruction particularly in respect to the emphasis which is placed upon the fundamental sciences. To the teacher in search of practical applications of science, the communication field will be found to contain an abundant supply of illustrations. Moreover, it will provide a wide range of phenomena differing from those of the electric power field and yet closely related to them and supplementing them in many ways.

For example, in considering the behavior of transmission lines in power systems, usual practice is to assume the resistance, inductance, and capacity of the line as lumped so as to form a simple network of impedance elements. While the approximation here involved is sufficiently accurate for most power problems, it fails of course to give a conception of the propagation of electric currents along lines. In telephone systems, because of the higher frequencies involved, the line is usually electrically long—that is, it includes a number of wave lengths—so that the approximation involved in making

single lumped constants out of the distributed constants of the line is wholly inadequate. For the telephone line, therefore, it is necessary to work out the solution on the basis of the propagation of currents or waves, determining the attentuation, phase-shift and reflection effects. The understanding coming from this more general treatment of the transmission line would be very helpful in preparing the way for the intelligent use of approximations where they are adequate and also for furnishing the basis for properly handling the longer power lines now being projected. By treating these two applications together, the general principles underlying both can be brought out and the possibility of confusion on the part of the student between the principles, methods of attack and the approximate formulas peculiar to each of them would naturally be lessened.

The details regarding the use of the subject matter of telephony and its allied fields in instruction each institution will doubtless prefer to solve in its own way. The situations existing at the various universities and technical schools probably differ so much from one another that an arrangement suitable at one might be of relatively little use at many others. There seems no greater need of unanimity in the manner of teaching communication material than now exists at various schools in regard to their electrical text books and lecture courses.

Regarding the Remodeling of Curricula

One point, however, appears worthy of emphasis. Today few if any text books on the fundamentals of electrical engineering recognize any alternating current frequencies except those commonly employed in power work. The same special point of view probably characterizes lecture courses where these in whole or in part take the place of texts. Hence the first question that arises is how to begin instruction in communication subjects—whether to recast at once the general courses,

or leave them unaltered and add to the curricula what may tentatively be called communication courses. If the latter procedure is followed, and under the circumstances it may seem the more expedient, it is recommended that steps be taken to prevent students reaching the conclusion that the new communication courses make a communication engineer while the old courses make a power engineer. If such an impression were to arise, it would probably prove unfortunate both to the students and to the communication industry. It is generally held that the best interests of both require the broadening rather than the narrowing of electrical training, and any policy which divides electrical instruction under two heads and brings pressure to bear upon the undergraduate to choose one or the other would seem to be a move in the wrong direction. This is borne out by the fact that many of the best engineers of the Bell System are men who, when they went through college, had no thought whatever of entering the telephone field and whose courses of study were not directed toward that end.

Bell System Cooperation

Because of the wide variety of ways in which communication material can be used, and used properly, in college instruction, the Bell System recognizes that its policy toward teaching institutions must be broad and scarcely definable by any single formula. It has for years secured for employment from the universities and colleges throughout the country many of their graduates, who, because of their education and training, have contributed in a marked degree to its development, progress and success. This has placed upon it an obligation to educational institutions, willingly acknowledged and accepted, but hard to discharge except through grateful appreciation. Because of the relationship between the industry and these institutions it would seem fitting that closer cooperation develop between them. As a first

move in this direction, and in order to make specific contribution to the cause of electrical engineering education the policy of loaning and donating apparatus to educational institutions is being developed. Distribution of certain apparatus which it is believed will be helpful in teaching laboratories is now under way to a selected list of schools, and if this undertaking, which is in an experimental stage, proves successful a wider distribution to other institutions will be a logical development.

To foster closer cooperation, a Bell System Educational Conference was held in New York in August, 1924, attended by representatives of faculties of electrical engineering departments from the schools to which the apparatus had been distributed. This conference resulted in a better understanding of the mutual problems of education and the industry and was of undoubted value in proving that by this means closer contact between the industry and educational institutions can be maintained. One of the important measures of assistance which it was believed the Bell System could render, was a more complete distribution of teaching material, including technical papers to enable faculty members to keep abreast of the developments in the communication art and to be a source of information in developing their courses. A bibliography is now being prepared and a routine of distribution established.

These are but illustrations of how the Bell System will endeavor to make available for instructional purposes all the information that circumstances will permit. It looks upon the colleges in turn as the proper interpreters of this material for their students. Theirs is the responsibility of putting it in such forms as will have the greatest instructional and training value when all the factors with which they have to deal at their respective institutions are taken into account. They need be guided only by the principle that the college graduate who enters industrial

employment possessing a well trained mind and a working knowledge of the underlying sciences, has what is now generally regarded as the preparation of greatest value, and that so far as the communication industry at least is concerned it is best to leave to the industry the teaching of the details of its practice and the special ramifications of its problems.

College Graduates in Communication Work

As being of interest both to the graduate in search of employment and to the university teacher who is sought by his students for advice regarding suitable employers, the following paragraphs will be devoted to a general survey of the records which college graduates have established in Bell System employ.

In the first place, the records show that a very satisfactory proportion of the college men entering this branch of the communication field remain permanently in it. The following data are typical. One of the associated companies of the Bell System, from 1907 to 1922 inclusive, employed 184 college graduates of whom, on January 1, 1923, 131 (or 70%) were still with the Bell System. Of the remaining 53, three had died and 50 entered other work, but 33 of the 50 were employed just prior to the war, later entered military service and afterward did not return to the Company.

Figures for another one of the associated companies while they do not cover as long a period, tell an interesting story. Of 222 technical graduates employed between 1917 and 1921, 201 or 90% were still in the system in October 1922.

In the Bell System as a whole, taking all those who have attained salaries of $3,000 or over, the turnover from all causes has latterly been at the low rate of about 1.2 per cent per year.

It has been the practice of each of the Bell System companies to maintain records of the progress of the col-

lege recruits in its own ranks, and these records are now supplemented by composite personnel records kept by the American Telephone and Telegraph Company at its headquarters, showing the education, position and salary of all men throughout the system who have reached a salary of $3,000 or more. It is hoped that these complete records, now being made available by the parent company, will enable each college to maintain contact with its graduates even though transferred to any one of the twenty-odd Bell companies. In addition, a rather detailed form for all college graduates entering the System from 1924 on is now being developed. One copy of this will be kept by the employing company and the other by the American Company. Part of it will be filled out by the student, giving certain personal data such as information about his college activities, other employment, etc., another part of the information will be obtained from the colleges concerning his scholastic record, and the third part will show his progress in the organization.

The question as to whether college training in addition to the four years of the bachelor's course makes for increased earning power is a question in which faculties and students alike are becoming more and more interested. Certain data are at hand relating to this question, but because of the many factors which enter it is by no means a simple task to appraise these at their true value. There seems to be no basis at present, however, for recommending that college students generally pursue their academic studies beyond the customary four years.

Opportunities in the Bell System Present and Future

In reply to a statement made to him to the effect that probably the pioneer work in telephony was now done, Mr. Thayer, President of the American Telephone and Telegraph Company, replied:

"Our pioneering work has just begun. Each day brings new problems, new discoveries, new develop-

ments, all calling for broader-visioned handling on a larger scale than ever before. If I were a young man again in years I would choose the telephone business for my life-work even more quickly than I did before."

Commenting on the present rate of growth, Mr. Gifford, Vice-President of the American Telephone and Telegraph Company, said recently:

"This year (1924) for instance, we are building gross construction of $360,000,000. In the planning and development of this work it is quite obvious that the greatest care must be taken that we always adopt the best, that we make no mistakes in our plans and that we engineer the entire program on sound lines. This is one of the reasons why we require so many technical men in the business."

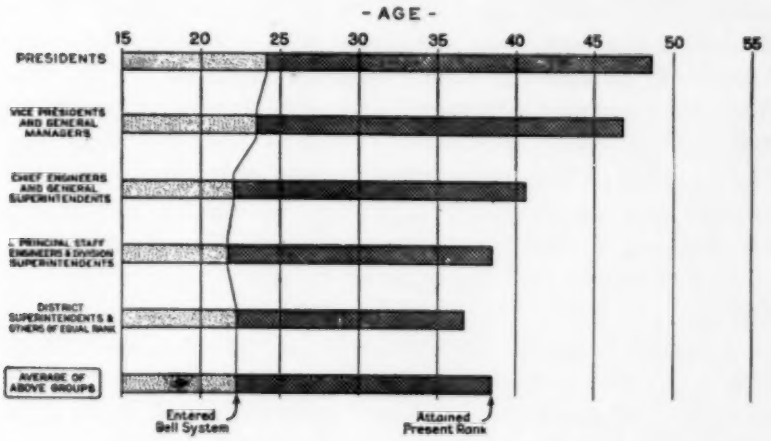
Such a rate of growth—and there is every indication that it will continue far into the future—cannot but supply ample opportunity to the young man who is capable and ambitious. Again regarding the need of well trained men in the Bell System, Dr. Jewett, Vice-President of the Western Electric Company, spoke not long ago as follows:

"Even today and despite the aggregation of human and material resources which have placed our laboratories in the front rank of industrial research organizations, there are on my list a large number of problems which we are not in a position to undertake. These problems, which are directly and solely in the communication field, are problems of major interest to the industry and are of such a nature that we are absolutely sure they can be solved with positive results of inestimable value to the telephone and telegraph companies and to the public at large, provided only that their solution can be obtained through the application of well-organized industrial research. Why then do these problems lie essentially untouched? Is it because of a lack of material facilities, of money, or courage to go

ahead, or the feeling that these particular researches will not recommend themselves to the business men who are responsible for the commercial destinies of the telephone and telegraph systems? It is none of these. There is no lack of money, no lack of material facilities, no lack of courage, no lack of approval on the part of the directors, for we have long ago learned that material facilities are easy to obtain.

"What then is it that should stop us from an immediate attack if we are so sure of the ultimate result? The answer is the simple, three-lettered word men . . . men endowed by nature with at least a modicum of the spirit of scientific research to which has been added . . . that orderly training and opportunity for expansion of intellect without which natural talents are of little avail."

Coupled with unusual opportunity for advancement goes a very enlightened policy of considering promotions and wage advances on the part of the Bell System. The aim throughout the entire organization, without ex-



ception, is to recognize ability. Promotions, both as regards responsibility and salary, in no way depend upon length of service. Merit receives prompt and propor-

tionate recognition, and due to the rate of growth of the industry there are always openings ahead.

Another feature of the personnel policy is that of filling important vacancies from those within the organization. That this policy is widely adhered to is illustrated by the accompanying chart which shows that those in the highest positions entered the Bell System at average ages ranging from 22 to 24 years. This chart also brings out the fact that progress in the Bell System is steady and sustained.

The fact that the Bell organization is one of the very largest does not interfere with promotion. Although it is large, it is nationwide and the great bulk of its work is decentralized. There are seventeen Associated Companies, each operating in an exclusive field and each fully responsible for the character of the telephone service (with the exception of the long lines service) in that field. Each company maintains its complete staff including on the technical side, a plant department, an engineering department, a traffic department and a commercial department. Supplementing the work of the Associated Companies there are two headquarters organizations, the American Telephone and Telegraph Company and the Western Electric Company, both of which have extensive engineering staffs and also research and development staffs. One of the main organization problems of a large corporation, particularly if widely scattered, is that of maintaining a common point of view and a common picture of its aims and aspirations in the minds of its employees. It would therefore be quite out of keeping with good policy to allow employees to become too narrow in their jobs, and in the technical departments it is becoming more and more the practice to circulate men from field positions to headquarters positions and vice versa.

Finally, work in the Bell System carries a very definite moral satisfaction. It is the greatest single public servant in the country, and all its activities and aims are based

upon the one proposition of rendering better and better service year after year. It is a work in which every employee comes closely in touch with the public, thus obtaining both a realization of the public wants and needs and the satisfaction of seeing these met to a steadily increasing extent.

R. I. REES
R. W. KING

The 1924 Stock Issue of the American Telephone and Telegraph Company

THE American Telephone and Telegraph Company on May 20, 1924 offered for subscription new stock to its stockholders of record on June 10, 1924 in the proportion of one share for each five shares then held. Thus determined, the stockholders had the right to subscribe for 1,511,575 shares of a par value of $151,157,500. It was the twenty-second offer so made by the Company and its predecessors and its successful completion on August 1st establishes another milestone in Bell System finance. So far as we know this was the largest operation of its kind ever carried out by any corporation. Its significance lies not only in the money value of the subscriptions received, but equally in the extent to which the stock was taken by investors, the number of subscribers to this new issue being 30,000 more than the total number of stockholders in any other corporation. As in the past the issue was not underwritten.

On June 10, 1924, the record date, there were 316,046 stockholders, an increase of about 10,000 over the number on the date of the offer 20 days before. At least 100,000 had become owners of their stock since the previous issue in 1922 and a very large proportion of these were probably unfamiliar with an operation of this kind. So it was quite essential to set out the terms of the offer as clearly as possible, not only for their benefit, but for that of other stockholders as well, for many of these too lacked a clear understanding of such an undertaking.

To this end the terms of the offer were made practically the same as for the issue of 1922 and every effort was made to have the circular describing the issue, which must necessarily be technical and exact, as clear and simple as possible; the subscription warrants mailed to the stockholders printed in several denominations,

re-stated the terms of the offer briefly, and the value of each warrant was shown for the first time in terms of rights in addition to shares; a letter of President Houston of the Bell Telephone Securities Company mailed with the warrants again informed stockholders, among other things, of their rights to subscribe for new stock and of the market value of these rights in case they should desire to purchase additional ones or to dispose of theirs. Accompanying this letter was a series of questions and answers, a new feature intended to convey clearly the information which experience had shown had not been understood by many subscribers heretofore, and for ready reference another copy of the stock circular was provided; and finally there was mailed with each July dividend check a further reminder of the termination of the subscription period on August 1st and of the amount of the payment then due.

Provision was made at the Treasurer's offices in New York and Boston to answer as promptly as possible every inquiry received in person or by mail and the Associated Companies were advised fully of all details to enable them to assist their employees and partons at their business offices by answering questions and as fully as possible in the purchase and sale of rights.

Few Fail to Exercise Rights

The success of the issue gives testimony as to the merits of placing the offer before stockholders in this painstaking manner. As usual a small percentage of the stockholders, however, failed to exercise their rights or to sell them, the amount of stock remaining unsubscribed being slightly over one per cent, and the number of stockholders thus affected probably 4,000. Our experience leads us to believe that this is an irreducible minimum. Analysis indicates that stockholders not utilizing their rights are to be found in no single group. There seem to be as many men among them as there are women; they live both in and near cities as well as in the country;

and while many of them hold only a few shares, others hold a substantial number. The refusal to read the communications sent them must be the best explanation. For example: A manager at a small business office called on the telephone patrons who had purchased through him shares of American Telephone stock and found as many as sixteen who had torn up their warrants believing them to be valueless, in spite of the fact that they had been fully advised in the letter accompanying the warrants of their market value and how they could easily dispose of them.

Facilities for the purchase and sale of rights were established for the first time in a large number of offices throughout the United States during this issue and in all there were 52,000 transactions effected by the Bell Telephone Securities Company in New York and through the Associated Companies at their business offices in those states where stock sales campaigns were being conducted by the Securities Company. Associated Companies reported that the contacts with their patrons, which this service furnished, provided an excellent opportunity for the cultivation and strengthening of their public relations. There is no question but that the service was greatly appreciated, especially by those who did not have regular banking or brokerage connections either because of their limited resources or because they were far removed from such facilities.

The stock could be paid for in full as of August 1st or in three installments as of August 1 and December 1, 1924 and April 1, 1925. The proceeds to date have been over $131,000,000 which amount includes payments of $2.75 per share received with full paid subscriptions. The installments not yet due amount to something over $21,000,000.

The Plan of the Issue

Having in mind that the entire proceeds of the stock issue would not be required for immediate investment

in telephone plant, the terms of the offer were arranged so that under either the full or partial payment plan the net rate paid on the money by the Company until April 1, 1925 would be six per cent. instead of the dividend rate of nine per cent. By this date all the stock subscribed and paid for will have been issued. The stock not subscribed for may now be sold at any time by the Company at the market price.

The amount of cash not required for early use was invested in short term obligations maturing at convenient dates, making the money readily available as needed by the Associated Companies for extensions to the nation-wide telephone system. Safety of principal has been the first consideration in the investment of these funds and the securities purchased have been mainly United States Treasury issues. These were all contracted for several weeks in advance and at prices materially less than it would have been necessary to pay later when the subscription payments were received.

The problems presented to the office of the Treasurer in the handling of this issue were interesting ones. We in the Bell System are accustomed to thinking in such large figures that probably few people have given much thought to the immense amount of detail involved in the handling of an issue of this magnitude. Stock issues such as this have been made at periods a few years apart and the time between the announcement of the offer of stock and the final subscription date is only a few weeks, so that the maintenance of a permanent organization for this purpose has not been practicable. For this reason and the necessity of giving notice to all stockholders simultaneously, the problem is unusual.

The issue this year was authorized by the Board of Directors at twelve o'clock on May 20th and by the closing hours of the work day over 305,000 circular letters to the stockholders had been enclosed in envelopes, sealed and placed in the post office and the news of the

issue given promptly to the press had probably reached every important newspaper in the United States and many abroad.

Increased Transactions in Stock

Immediately the daily transactions in the stock increased, and on June 10th, the record date, the conversion of bonds, the issue of new shares to employees who had anticipated their final payments under the Employees' Stock Plan, the transfer of shares to purchasers under the Direct Sales Plan of the Bell Telephone Securities Company who had completed payments in order to secure rights as well as the recording of the new owners who had bought stock through brokers, were all substantially larger than at normal periods.

On the day following the record date it was necessary to balance the 316,000 stockholders' accounts for the purpose of determining the subscription rights to which each stockholder was entitled and five days thereafter 435,000 subscription warrants with which was enclosed the letter of the Bell Telephone Securities Company were mailed to the stockholders.

Then began the period of seven weeks for receivings subscriptions. During this time over 193,000 subscription were received, over half of them during the final week, verified and recorded; about 100,000 individual communications were received and acted upon, requiring in excess of 23,000 personal replies and an unrecorded number of form letters; 46,000 new warrants were issued in making transfers and over 2,200 duplicate warrants to take the place of those lost or destroyed; and the normal activities of the office were carried on as usual. One hundred and forty-six thousand stock certificates were issued to those who paid in full and were delivered over the counter and by registered mail, but these could not be released until the collection of the checks sent in payment of subscriptions was assured.

The force of the office of the Treasurer during the latter part of the period was nearly tripled, the temporary employees numbering then about 435 were recruited entirely from outside sources. New employees were added daily after the issue was announced until the force reached its maximum, a short time before August 1st. The new employees were trained as rapidly as possible, and then, after the lapse of a few weeks, the work was practically all over and they were released.

The Company was most fortunate in finding available a high class of employee, many of whom were students on summer vacations. In contact with the regular force they readily acquired the Bell System spirit in their dealings with the public over the counter and by correspondence as well as with one another.

It is interesting to note the confidence which the stockholders showed towards the Company, numerous checks being received which were blank as to the amounts, accompanied by letters requesting that the proper figures be filled in in order to put through their subscriptions. And there were many other cases in which the character of the stockholders' communications placed the matter of making their subscriptions entirely in the hands of the Company.

Some Interesting Figures

Some additional statistics of the 1924 issue will prove interesting. Of the 193,000 subscriptions 140,000 were made under the full payment plan and 53,000 under the installment plan. The average subscription under the former was 8.7 shares, under the latter 5.1 shares, making the average for all 7.7 shares. Fifty-five per cent. of the 316,000 stockholders of June 10th subscribed for additional stock and the shares taken by them were 86 per cent. of the total amount subscribed, the balance of 14 per cent. having been taken by 18,000 investors who did not at the time own any stock. Since June 10, 1924, the record date, by reason of the purchase by the

public of rights and of stock in the market at the market price over 24,000 stockholders of record have been added, making the total number now over 340,000. Others, who subscribed under the installment plan, will become stockholders of record when they have completed their subscription payments. The average number of shares now outstanding is 26 per stockholder.

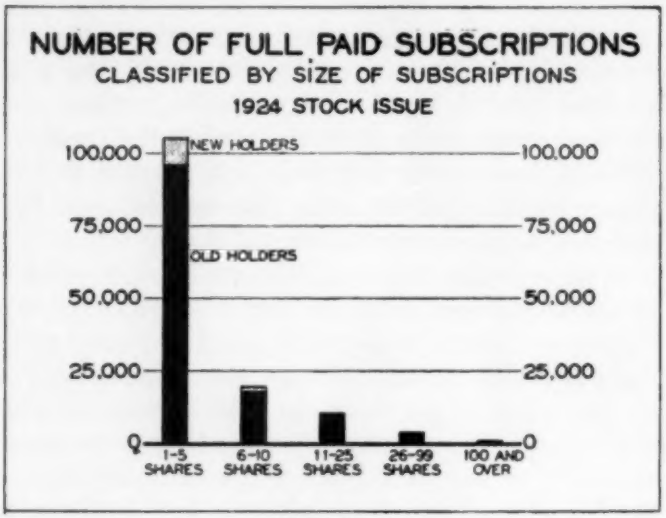


Chart No. 1

At the time of writing, complete statistical data have been compiled for the 140,000 full paid subscriptions only.

Chart No. 1 shows these classified as to shares paid for in full in groups of one to five shares, six to ten shares, etc. The shaded portion at the top of the columns represents the number of new stockholders gained in each group. Seventy-five per cent. of the number gained are among the subscribers in the lowest group.

Chart No. 2 shows the number of full paid subscriptions classified between men, women, corporations, trustees, and brokers. On the record date, June 10th, the men represented 42 per cent. of the total stockholders and the women 53 per cent. Of the subscribers who

paid in full, men were 45 per cent. and women 51 per cent. Men paid in full for an average of 8.2 shares each while women paid in full for an average of 4.65 shares each.

The active demand for the new stock indicates the desire for it for investment purposes is as strong as the demand for new telephones. The new issue added even further strength to the capital structure. The capital

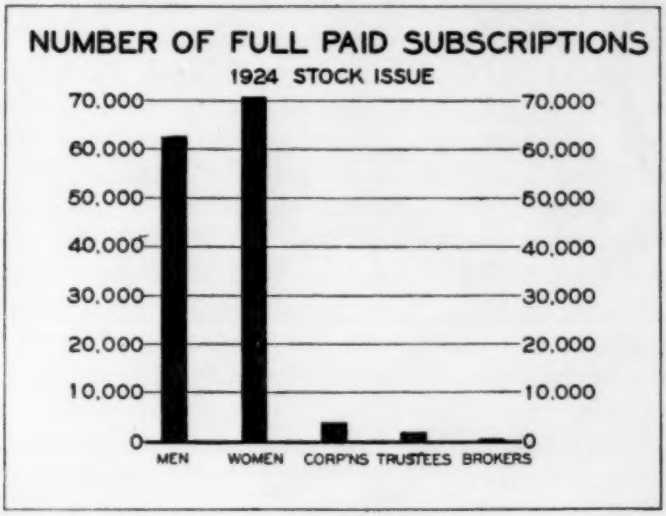


Chart No. 2

stock of the Bell System now outstanding in the hands of the public including the shares of this issue subscribed for under the partial payment plan but not yet fully paid is 59 per cent. of all capital obligations and interest bearing securities 41 per cent.

It would be inappropriate to close this article without a word of commendation of the spirit which manifested itself in the employees throughout the Bell System to make this issue a success in every way. This they did as is shown by the statistical figures given, and by many enthusiastic letters received with subscriptions from patrons and stockholders.

H. BLAIR-SMITH.

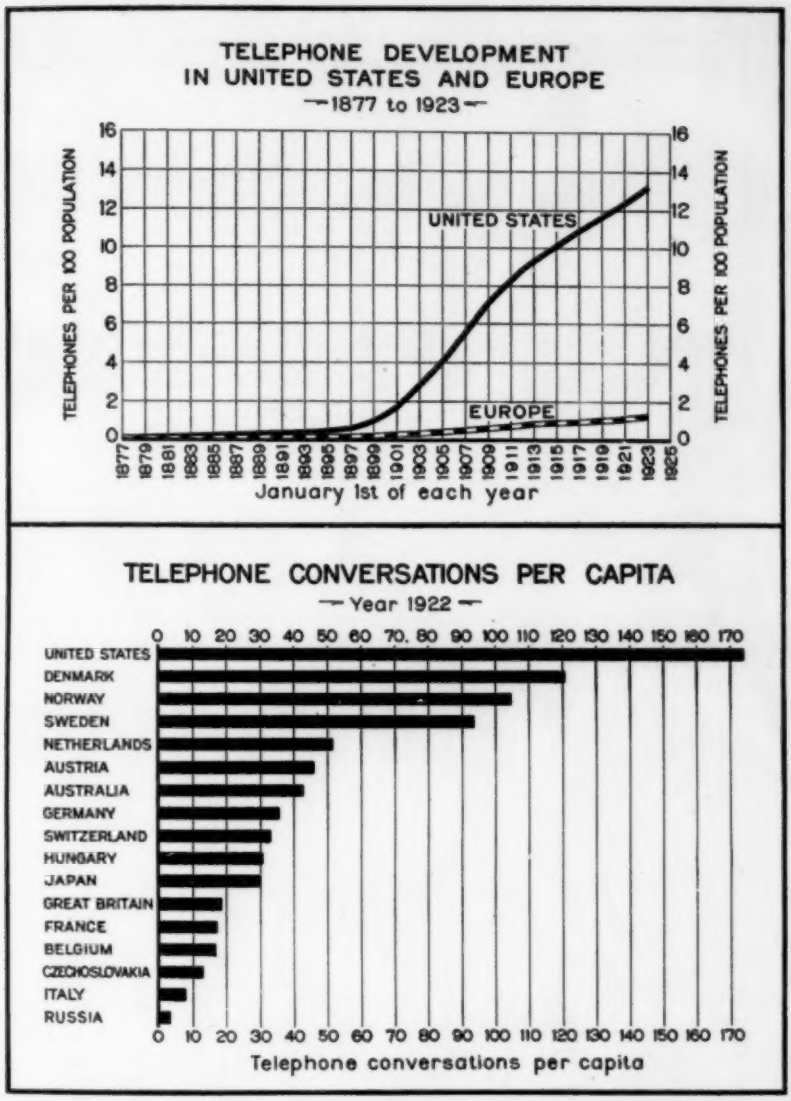
World's Telephone Statistics, 1923

THE total number of telephones in the world on January 1, 1923 was 22,904,415, an increase during the year 1922 of 1,100,161, according to a compilation recently completed and published by the Chief Statistician's Division of the American Telephone and Telegraph Company. Sixty-three percent, or 14,347,395, of the world's telephones were in the United States. Of this number 14,050,565, or over 61% of the total telephones in use in the world, were connected to the Bell System. The number of telephones in Europe on January 1, 1923 was 5,863,684, or 26% of the total in the world; all other countries, including the whole of Asia, Africa, Oceania, and the entire Western Hemisphere outside of the United States, had at that date only 2,693,336 telephones, or 11% of the total number then in service throughout the world. At the beginning of 1923 there were 1.3 telephones for each 100 inhabitants of the world. The similar ratio of telephones to population in the United States was 13.1. This country, therefore, has ten times as many telephones, in proportion to population, as the world at large. It is interesting to note that the United States in 1900 had reached a point of telephone development which was not achieved in Europe until 1923.

Method of Compilation

The accompanying tables and charts have been taken from the compilation mentioned above. This compilation is the only one made by any organization, either in this country or abroad, which is based upon a canvass of the telephone systems in each country in the world, regardless of size. In the course of this canvass, which was conducted through correspondence, letters requesting authoritative data were sent not only to the larger countries, but also to the scores of small countries, including colonial possessions and principalities. In general, a hearty spirit of cooperation was evidenced by all corre-

spondents, with the result that complete official data were received from nearly all countries. In the relatively few



instances in which it was necessary to resort to estimates, it was possible to base these estimates upon accurate information of an earlier date.

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES

January 1, 1923

	Number of Telephones					
	Government Systems	Private Companies	Total	Per Cent. of Total World	Telephones per 100 Population	Increase in Number of Telephones during 1922†
NORTH AMERICA:						
United States	.....	14,347,395	14,347,395**	62.64%	13.1	620,670
Canada	196,800	747,229	944,029	4.12%	10.4	41,939
Central America	6,718	10,427	17,145	.07%	0.3	568
Mexico	1,860	46,069	47,929	.21%	0.4	2,513
West Indies:						
Cuba	500	41,047	41,547	.18%	1.4	3,509
Porto Rico	615	9,756	10,371	.05%	0.8	1,269
Other W. I. Places*	3,589	8,332	11,921	.05%	0.2	1,021
Other No. Am. Places*	60	3,500	3,560	.02%	1.0	110
Total	210,142	15,213,755	15,423,897	67.34%	10.4	671,599
EUROPE:						
Austria	133,400	.....	133,400	.58%	2.0	1,100
Belgium	96,516	.....	96,516	.42%	1.3	16,007
Bulgaria	7,052	.....	7,052	.03%	0.1	452
Czechoslovakia	84,330	.....	84,330	.37%	0.6	2,377
Denmark	9,407*	267,182	276,589	1.21%	8.3	*8,000
Finland	.....	70,500	70,500	.31%	2.1	500
France	524,592	.....	524,592	2.29%	1.3	11,285
Germany	2,073,308	.....	2,073,308	9.05%	3.5	127,707
Great Britain and No. Ireland	1,045,928	.....	1,045,928	4.57%	2.3	48,123
Greece	5,357	.....	5,357	.02%	0.1	357
Hungary	70,816	.....	70,816	.31%	0.9	8,316
Irish Free State (March 31, 1923)	19,610	.....	19,610	.09%	0.6	‡
Italy (June 30, 1922)*	86,100	39,000	125,100	.55%	0.3	5,000
Jugo-Slavia	24,178	.....	24,178	.10%	0.2	2,480
Netherlands	184,113	1,009	185,122	.81%	2.6	9,098
Norway (June 30, 1922)	91,524	66,786§	158,310	.69%	5.8	5,968
Poland	60,629	38,964	99,593	.43%	0.4	21,674
Portugal	2,000*	15,987	17,987	.08%	0.3	1,278
Roumania (March 31, 1923)*	31,100	.....	31,100	.14%	0.2	1,500
Russia‡	112,000	.....	112,000	.49%	0.1	—58,741
Spain	23,536	58,414	81,950	.36%	0.4	‡
Sweden	392,815	1,720	394,535	1.72%	6.6	8,932
Switzerland	167,440	.....	167,440	.73%	4.3	5,735
Other Places in Europe*	47,393	10,978	58,371	.25%	0.6	11,662
Total	5,293,144	570,540	5,863,684	25.60%	1.2	243,000
SOUTH AMERICA:						
Argentine						

Total	5,293,144	570,540	5,863,684	25.60%	1.2	243,000
SOUTH AMERICA:						
Argentine	.....	143,093	143,093	.63%	1.6	12,366
Bolivia	.....	2,706	2,706	.01%	0.1	97
Brazil	598	89,514	90,112	.39%	0.3	2,526
Chile	.....	30,520	30,520	.13%	0.8	859
Colombia	.....	9,958	9,958	.04%	0.2	2,657
Ecuador	1,675	2,605	4,280	.02%	0.2	244
Paraguay	90	341	431	.002%	0.04	25
Peru	2	8,917	8,919	.04%	0.2	298
Uruguay	.....	24,397	24,397	.11%	1.6	349
Venezuela	444	9,882	10,326	.05%	0.4	1,145
Other Places	2,226	.....	2,226	.01%	0.5	93
Total	5,035	321,933	326,968	1.43%	0.5	20,659
ASIA:						
British India (March 31, 1923)	13,337	25,590	38,927	.17%	0.01	2,570
China*	63,552	28,218	91,770	.40%	0.03	8,334
Japan	519,630	.....	519,630	2.27%	0.9	94,593
Other Places in Asia*	60,327	13,822	74,149	.32%	0.05	13,720
Total	656,846	67,630	724,476	3.16%	0.1	119,217
AFRICA:						
Egypt	28,358	.....	28,358	.12%	0.1	3,173
Union of South Africa¶	60,210	.....	60,210	.26%	0.8	4,129
Other Places in Africa*	39,253	1,130	40,383	.18%	0.03	5,000
Total	127,821	1,130	128,951	.56%	0.1	12,302
OCEANIA:						
Australia (June 30, 1922)	258,477	.....	258,477	1.13%	4.6	17,970
Dutch East Indies*	36,000	2,000	38,000	.17%	0.1	1,159
Hawaii	.....	16,074	16,074	.07%	5.8	950
New Zealand (March 31, 1923)	107,036	.....	107,036	.47%	8.1	12,353
Philippine Islands*	2,310	11,900	14,210	.06%	0.1	680
Other Places in Oceania*	2,218	424	2,642	.01%	0.1	272
Total	406,041	30,398	436,439	1.91%	0.6	33,384
TOTAL WORLD	6,699,029	16,205,386	22,904,415	100.00%	1.3	1,100,161

*Partly estimated. †Minus sign preceding a figure denotes decrease. ¶March 31, 1923.
♯Accurate data not available, and basis for reliable estimate lacking. An arbitrary estimate, however, is included in total for Europe.
§January 1, 1923. ‡Including Siberia.
**As reported by the United States Department of Commerce, Bureau of the Census.

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES IN IMPORTANT COUNTRIES

January 1, 1923

Country	Service Operated by (See Note)	Number of Telephones		Telephones per 100 Population	
		In Communities of 100,000 Population and Over	In Communities of less than 100,000 Population	In Communities of 100,000 Population and Over	In Communities of less than 100,000 Population
Australia	G.	162,524	107,566	6.7	3.4
Austria	G.	91,600	41,800	4.5	0.9
Belgium	G.	63,125	33,391	3.0	0.6
Canada	P. G.	337,092	606,937	15.3	8.9
Czechoslovakia	G.	29,494	54,836	3.3	0.4
Denmark	P. G.	105,851	170,738	14.5	6.5
France♯	G.	251,316	261,991	4.1	0.8
Germany	G.	1,121,962	951,346	7.4	2.2
Great Britain and Northern Ireland§	G.	789,612	261,060	3.3	1.2
Hungary	G.	47,506	23,310	4.1	0.3
Italy (June 30, 1922)	P. G.	72,534	52,566*	1.5	0.1
Japan♯	G.	256,058	168,979	3.5	0.3
Netherlands	G.	97,529	87,593	5.3	1.7
New Zealand (March 31, 1923)	G.	40,666	66,370	10.3	7.1
Norway (June 30, 1922)	P. G.	32,441	125,869	12.5	5.1
Poland	P. G.	45,395	54,198	2.3	0.2
Russia	G.	37,581	74,419	1.1	0.1
Spain	P. G.	47,790	34,160	1.8	0.2
Sweden	G.	146,151	248,384	19.0†	4.8
Switzerland	G.	59,013	108,427	10.3	3.3
United States	P.	6,150,785	8,196,610	17.2	11.1

Note: P. indicates telephone service operated by private companies, G. by the Government, and P. G. by both private companies and the Government.

§March 31, 1923.

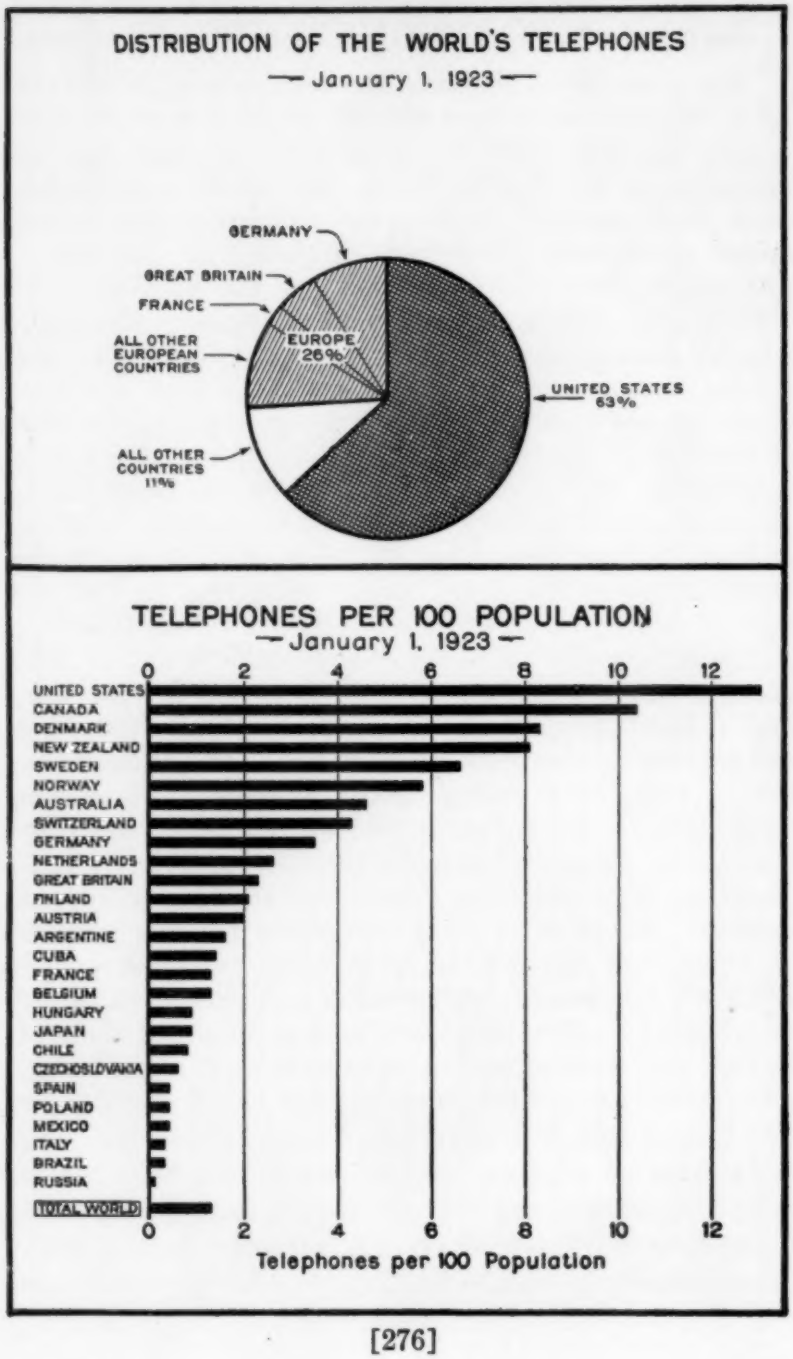
†The majority of this development is due to Stockholm.

♯January 1, 1922.

*Partly estimated.

Comparative Telephone Development of Countries

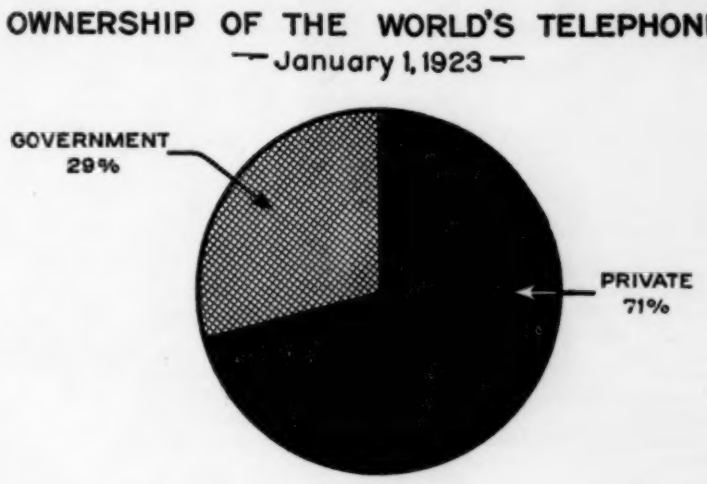
The table on "Telephone Development of the World, by Countries" shows that 620,670 telephones were added during the year 1922 to the private company systems operating in the United States, which was considerably more than one-half of the total number of telephones added throughout the world. Whereas on January 1, 1923 there were 13.1 telephones per 100 population in the United States, the highest developed European country from a telephone standpoint was Denmark, with 8.3 instruments per 100 inhabitants. In fact, the telephone development of Denmark is exceeded only by that of the United States and Canada; in this connection it is noteworthy that the telephone service in Denmark is operated almost entirely by private companies. Europe as a whole, notwithstanding the relatively high telephone development in the Scandinavian countries, had at the date to which these figures refer, only 1.2 telephones for every 100 people. The telephone development of Belgium, whose system was greatly disrupted by the war, had at the beginning of 1923 risen to 1.3 telephones per 100 population, due to an increase of over 19% in the number of telephones during 1922. Germany, which has been building up its state-owned system more vigorously than other European powers, added over 127,000 telephones during 1922, more than half of the total European increase. In point of total telephones and the number of telephones relative to population, Germany with 2,073,308 telephones, representing a development of 3.5 telephones for every 100 inhabitants, is far ahead of Great Britain and France with a combined total of 1,570,520 telephones and relative developments of 2.3 and 1.3 per 100 inhabitants, respectively. Russia, which has long had the lowest telephone development of any large nation in Europe, experienced a substantial set-back during 1922, losing over 58,000 telephones. Among the South American countries, Argentine increased its development dur-


DISTRIBUTION OF THE WORLD'S TELEPHONES
— January 1, 1923 —
GERMANY
GREAT BRITAIN
FRANCE
ALL OTHER EUROPEAN COUNTRIES
EUROPE 26%
UNITED STATES 63%
ALL OTHER COUNTRIES 11%
TELEPHONES PER 100 POPULATION
— January 1, 1923 —
0 2 4 6 8 10 12
UNITED STATES
CANADA
DENMARK
NEW ZEALAND
SWEDEN
NORWAY
AUSTRALIA
SWITZERLAND
GERMANY
NETHERLANDS
GREAT BRITAIN
FINLAND
AUSTRIA
ARGENTINE
CUBA
FRANCE
BELGIUM
HUNGARY
JAPAN
CHILE
CZECHOSLOVAKIA
SPAIN
POLAND
MEXICO
ITALY
BRAZIL
RUSSIA
TOTAL WORLD
0 2 4 6 8 10 12
Telephones per 100 Population

ing 1922 from 1.5 to 1.6 telephones per 100 population, thus equalling the development of its sister republic, Uruguay. Of the Asiatic countries, Japan easily leads in telephone activity both in respect of actual number of telephones and in relation of telephones to population. An increase of over 22%, or 94,593 telephones, was reported for Japan during 1922. Progress during 1923 in Japan has, of course, been retarded by the disastrous earthquake of September, 1923. China's 325,000,000 inhabitants are served by only 91,770 telephones.

Comparative Use of the Telephone

The charts reproduced herewith clearly indicate the pre-eminent position of the United States in world telephony. Whereas 71% of the total telephones in the world are operated by private companies, over 88% of such privately owned telephones are in the United States. Private ownership is undoubtedly largely responsible for



the remarkable progress and universal utilization of the telephone in the United States. As shown by one of the charts, the number of telephone conversations per capita in the United States during 1922 amounted to 174. The

TELEPHONE DEVELOPMENT OF IMPORTANT CITIES—Jan. 1, 1923

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINE:			
Buenos Aires	1,720,000	76,186	4.4
AUSTRALIA:			
Adelaide	270,000	18,228	6.7
Brisbane	230,000	14,300	6.2
Melbourne	817,000	54,081	6.6
Sydney	956,000	66,545	7.0
AUSTRIA:			
Gratz	160,000	5,600	3.5
Vienna	1,860,000	86,000	4.6
BELGIUM:			
Antwerp	468,000	14,794	3.2
Brussels	872,000	33,479	3.8
Charleroi	206,000	3,212	1.6
Ghent	279,000	4,392	1.6
Liege	301,000	7,248	2.4
CANADA:			
Montreal	892,000	92,376	10.4
Ottawa	167,000	27,279	16.3
Toronto	583,000	112,211	19.2
CHINA:			
Canton	909,000	2,570	0.3
Shanghai	1,515,000	18,351	1.2
Tientsin	808,000	7,062	0.9
Peking	1,313,000	32,000*	2.4
CUBA:			
Havana	465,000	30,436	6.5
CZECHOSLOVAKIA:			
Prague	683,000	22,296	3.3
DANZIG, FREE CITY OF	365,000	13,075	3.6
DENMARK:			
Copenhagen	729,000	105,851	14.5
FRANCE:*			
Bordeaux	270,000	8,700	3.2
Lille	203,000	5,600	2.8
Lyons	568,000	12,000	2.1
Marseilles	592,000	13,000	2.2
Paris	2,935,000	185,000	6.3
GERMANY:			
Berlin	3,842,000	357,062	9.3
Bremen	273,000	22,361	8.2
Breslau	533,000	31,168	5.8
Chemnitz	307,000	16,442	5.4
Cologne	640,000	41,748	6.5
Dresden	594,000	38,437	6.5
Dusseldorf	411,000	29,657	7.2
Essen	443,000	17,441	3.9
Frankfort-on-Main	437,000	40,622	9.3
Hamburg-Altona	1,167,000	113,882	9.8
Hannover	397,000	25,116	6.3
Leipzig	610,000	46,918	7.7
Magdeburg	289,000	16,057	5.6
Munich	637,000	50,005	7.9
Nuremburg	357,000	25,354	7.1
Stuttgart	312,000	27,366	8.8
GREAT BRITAIN AND NO. IRELAND:‡			
Belfast	418,000	9,500	2.3
Birmingham	1,298,000	29,588	2.3
Blackburn	254,000	5,338	2.1
Bolton	285,000	5,414	1.9
Bradford	383,000	13,246	3.5
Bristol	413,000	10,780	2.6
Edinburgh	428,000	17,353	4.1
Glasgow	1,285,000	44,128	3.4
Hull	331,000	13,872	4.2
Leeds	547,000	14,308	2.6
Liverpool	1,214,000	40,700	3.4
London	7,210,000	364,494	5.1
Manchester	1,623,000	51,644	3.2
Newcastle	609,000	14,525	2.4
Nottingham	341,000	10,022	2.9
Plymouth	235,000	4,298	1.8
Sheffield	515,000	12,618	2.5

*Partly estimated.
‡March 31, 1923.

TELEPHONE DEVELOPMENT OF IMPORTANT CITIES—Jan. 1, 1923

(Concluded)

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
HUNGARY:			
Budapest	935,000	44,095	4.7
Szegedin	111,000	2,065	1.9
IRISH FREE STATE:‡			
Dublin*	395,000	12,000	3.0
ITALY:†			
Florence	249,000	4,684	1.9
Genoa	302,000	8,105	2.7
Milan	707,000	17,258	2.4
Naples	777,000	6,437	0.8
Palermo	404,000	2,515	0.6
Rome	642,000	14,164	2.2
Turin	504,000	7,545	1.5
Venice	167,000	2,572	1.5
JAPAN:*			
Kobe	643,000	19,700	3.1
Kyoto	619,000	18,700	3.0
Nagoya	623,000	15,800	2.5
Osaka	1,309,000	61,500	4.7
Tokio	2,327,000	108,700	4.7
Yokohama	435,000	13,000	3.0
JUGO-SLAVIA:*			
Belgrade	113,000	3,200	2.8
NETHERLANDS:			
Amsterdam	696,000	33,768	4.8
The Hague	366,000	25,706	7.0
Rotterdam	532,000	26,690	5.0
NEW ZEALAND:‡			
Auckland	168,000	14,215	8.5
Christchurch	113,000	11,012	9.7
Wellington	112,000	15,439	13.8
NORWAY:†			
Bergen	96,000	8,662	9.0
Christiania	260,000	32,441	12.5
ROUMANIA:*			
Bucharest	353,000	9,000	2.5
RUSSIA:			
Kazan	158,000	792	0.5
Kharkov	310,000	2,096	0.7
Moscow	1,511,000	24,950	1.7
Odessa	317,000	777	0.2
Petrograd	1,071,000	8,966	0.8
SWEDEN:			
Göteborg	228,000	25,234	11.1
Malmö	115,000	12,938	11.3
Stockholm	425,000	107,979	25.4
SWITZERLAND:			
Basel	137,000	12,538	9.1
Berne	103,000	10,703	10.4
Geneva	134,000	14,189	10.6
Zurich	199,000	21,583	10.8
UNITED STATES:§			
New York	5,884,000	1,072,632	18.2
Chicago	2,858,000	638,650	22.3
Total of the 6 cities with over 1,000,000 population	14,440,000	2,663,032	18.4
Cincinnati	592,000	109,206	18.5
Los Angeles	833,000	189,458	22.7
San Francisco	687,000	172,742	25.2
Total of the 11 cities with 500,000-1,000,000 population	7,514,000	1,261,414	16.8
Washington	452,000	103,085	22.8
Minneapolis	420,000	101,529	24.2
Denver	274,000	62,987	23.0
Omaha	210,000	58,826	28.0
Total of the 25 cities with 200,000-500,000 population	7,210,000	1,268,747	17.6
Total of the 42 cities with over 200,000 population	29,163,000	5,193,193	17.8

§In addition to New York and Chicago, the largest cities, there are shown, for purposes of comparison with cities in other countries, the total development of all cities in certain population groups and the development of certain representative cities within each group.

*Partly estimated. ‡March 31, 1923. †June 30, 1922.

closest approach to this degree of telephone usage was made by the Scandinavian countries, Denmark, Norway and Sweden, for which countries calling rates were reported ranging from 93 to 120 conversations per capita for the year. The telephone service in these countries is either rendered by private companies or else was largely developed by, or received its first impetus from, private initiative. The Netherlands and Austria, with telephone service publicly owned and operated, rank next, but reported only 51 and 46 conversations per capita, respectively. Italy, where the Government has decided to return its state-owned telephones to private ownership, reported only 7.7 conversations per capita.

Rural and Urban Telephone Development

In the United States a large proportion of the total telephones are in the rural areas, whereas in Europe telephone development is largely concentrated in the capital cities and important commercial centers. The more equitable distribution of telephones in the United States as between large and small communities is revealed by the table on "Telephone Development of Large and Small Communities in Important Countries."

The table on "Telephone Development of Important Cities" is of special interest when concurrent reference is made to the table on "Telephone Development of the World, by Countries." For instance, New York City has more telephones than the whole of Great Britain and Northern Ireland, although there are less than one-seventh as may people in New York City as in Britain and Ulster, Chicago has more telephones than France, while San Francisco has more telephones than Italy. In fact, Germany is the only country in the world which is not exceeded in point of number of telephones by one or more American cities. A surprising fact revealed by this table is that, although in foreign countries telephone development is more or less confined to the larger cities,

NOTE—This chart shows the comparative telephone development of the largest cities in the countries listed on the preceding pages. The United States cities shown include, in addition to New York and Chicago, a number of representative cities having a population between 200,000 and 1,000,000.

it is still very rare to find a large city having more than 10 telephones per 100 population outside the United States and Canada. London has only 5.1 telephones per 100

of its inhabitants, Paris 6.3, and Rome only 2.2 telephones per 100 population. Of the foreign capitals Stockholm has by far the best telephone development. In that city there were, on January 1, 1923, 25.4 telephones per 100 population. This development was largely secured by a private company which operated in Stockholm until its plant and property were taken over by the Government in 1918. The best developed city among those shown in this table is Omaha, Nebraska, with a development of 28.0 telephones per 100 population.

C. W. Foss.

NOTE—Mr. Foss is of the staff of the Chief Statistician of the American Telephone and Telegraph Company.

Abstracts of Recent Technical Papers from Bell System Sources

Electrical Tests and Their Applications in the Maintenance of Telephone Transmission,[1] by W. H. Harden. This paper describes the more important electrical testing methods used today in installation and maintenance work in the telephone plant to insure satisfactory speech transmission. Direct current tests are described first and later alternating current tests, the field of application of each being discussed in some detail. Under direct current tests, the methods of measuring resistance, resistance balance, leakage and current flow are considered, standard types of test boards being described to illustrate the practical applications of these methods. Under alternating current tests four fundamental bridge methods for measuring capacity, capacity unbalance, impedance and apparatus balance are first described. Following this, noise and cross-talk tests are covered and also 21 circuit balance tests, these later having become of particular importance in connection with telephone repeater maintenance. Transmission efficiency testing methods for both losses and gains are described in considerable detail and a discussion is given of the results accomplished by this testing work. A description is also given of the standard oscillators required in the various alternating current tests mentioned above.

An Intermittent Immersion Test as an Aid in Evaluating Zinc Coats Plated on Iron and Steel,[2] by F. F. Farnsworth and C. D. Hocker. A test for evaluating the quality of an electrodeposit of zinc on iron and steel is described; it consists of a series of immersions of the samples in a solution of ammonium chloride, alternating with periods of drying in the air. The test shows up discontinuities and thin spots in zinc coatings in a discriminating manner; it differentiates zinc coatings plated from a sulfate

[1] Bell System Technical Journal, Vol. III, page 353, 1924.

[2] Trans. Am. Electrochem. Soc., Apr. 1924, Vol. 45.

and from a cyanide bath; and it may be used to compare the effectiveness of different methods of precleaning the iron and steel before plating.

Abstract:—Vacuum Tube Oscillators—A Graphical Method of Analysis,[3] by J. W. Horton. The oscillator is considered as a special form of regenerative system, and the conditions necessary for its stable operation are defined. It is pointed out that any change in the characteristic of one element of such a system must be accompanied by a general readjustment of the characteristics of the remaining elements in order for equilibrium conditions to be preserved. Those characteristics of the several elements constituting the system which have a determining influence upon its operation are discussed, and a graphical method of studying the reaction ofvariations in one or more of these characteristics upon the equilibrium condition is developed. The application of this method of analysis to the particular problem of frequency stability is considered in some detail.

A Generalization of the Reciprocal Theorem,[4] by John R. Carson. This paper demonstrates an extension of Rayleigh's Reciprocal Theorem which may be stated as follows: Let a distribution of impressed periodic electric intensity $\mathbf{F}' = \mathbf{F}'(x,y,z)$ produce a corresponding distribution of current intensity $\mathbf{u}' = \mathbf{u}'(x,y,z)$, and let a second distribution of equi-periodic impressed electric intensity $\mathbf{F}'' = \mathbf{F}''(x,y,z)$ produce a second distribution of current intensity $\mathbf{u}'' = \mathbf{u}''(x,y,z)$, then

$$\int(\mathbf{F}'.\mathbf{u}'')\,dv = \int(\mathbf{F}''.\mathbf{u}')dv,$$

the volume integration being extended over all conducting and dielectric media. **F** and **u** are vectors and the expression (**F.u**) denotes the scalar product of the two vectors.

The only serious restriction on the generality of this theorem, as proved in this paper, is that magnetic matter is excluded; in other words it is assumed that all con-

[3] Bell System Technical Journal, Vol. III, page 508, 1924.
[4] Bell System Technical Journal, Vol. III, page 393, 1924.

ducting and dielectric media in the field have unit permeability.

The Transmission Unit and Telephone Transmission Reference Systems,[5] by W. H. Martin. Consideration is given to the method of determining and expressing the transmission efficiencies of telephone circuits and apparatus, and of the desirable qualifications for a unit in which to express these efficiencies. The "transmission unit" described in this paper has been selected as being much more suitable for this purpose under present conditions than the "mile of standard cable" which has been generally used in the past.

The "transmission unit" (abbreviated TU) has been chosen so that two amounts of power differ by one transmission unit when they are in the ratio of $10^{0.1}$ and any two amounts of power differ by N units when they are in the ratio of $10^{N(0.1)}$.

Practical Application of the Transmission Unit,[6] by C. W. Smith. The purpose of this paper is to outline the practical considerations involved in the use of the transmission unit which was recently adopted by the Bell System to replace the mile of standard cable in transmission engineering work.

Impedance of Loaded Lines and Design of Simulating and Compensating Networks,[7] by Ray S. Hoyt. A knowledge of the impedance characteristics of loaded lines is of considerable importance in telephone engineering, and particularly in the engineering of telephone repeaters. The first half of the present paper deals with the impedance of non-dissipative loaded lines as a function of the frequency and the line constants, by means of description accompanied by equations transformed to the most suitable forms and by graphs of those equations; and it outlines qualitatively the nature of the modifications produced by dissipation. The characteristics are

[5] Journal of A. I. E. E., for June, 1924.
Bell System Technical Journal, Vol. III, page 400, 1924.
[6] Bell System Technical Journal, Vol. III, page 409, 1924.
[7] Bell System Technical Journal, Vol. III, page 415, 1924.

correlated with those of the corresponding smooth line.

The somewhat complicated effects produced by the presence of distributed inductance are investigated rather fully. In the absence of distributed inductance a loaded line would have only one transmitting band, extending from zero frequency to the critical frequency. Actually, however, every line—even a cable—has some distributed inductance; and the effect of distributed inductance, besides altering the nominal impedance and the critical frequency, is to introduce into the attenuating range above the critical frequency a series of relatively narrow transmitting bands—here termed the "minor transmitting bands"—spaced at relatively wide intervals. The paper is concerned primarily with the impedance in the first or major transmitting band; but it investigates the minor transmitting bands sufficiently to determine how they depend on the distributed inductance, and to derive general formulas and graphical methods for finding their locations and widths—an investigation involving rather extensive analysis.

The latter half of the paper describes various networks devised for simulating and for compensating the impedance of loaded lines; it furnishes design-formulas and supplementary design-methods for all of the networks depicted; and outlines a considerable number of applications pertaining to lines and to repeaters.

Some Very Long Telephone Circuits of the Bell System,[8] by H. H. Nance. Recent papers have discussed at length the use of toll cables for the handling of certain long distance traffic. These cables, which are being used in areas of dense traffic, have been made possible by many developments in cable design, repeaters and loading coils. Coincident with these developments have gone others which are finding their application in the extensive establishment of improved open wire circuits for use over very long distances. The purpose of the present paper is to

[8] Bell System Technical Journal, Vol. III, page 495, 1924.

discuss some of the considerations involved in the overall design and maintenance of these very long open wire circuits. These circuits are often referred to as "backbone" circuits and supply a network of trunk lines for the entire Bell System.

An Explanation of Peculiar Reflections Observed on X-Ray Powder Photographs,[9] by Richard M. Bozorth.[1] There has been previously reported (J. O. S. A. and R. S. I. 6, 989-97; 1922) the existence of "anomalous" reflections of X-rays, observed when analyzing substances by the method of Debye-Scherrer and Hull. These reflections are now explained in accordance with the well-known laws governing X-ray reflections. It is shown that the molybdenum X-ray spectrum as ordinarily used, although it is filtered by zirconium screens, contains in addition to the characteristic Ka radiation a considerable amount of general radiation. Although usually not effective, this general radiation becomes important when the sample being analyzed is composed of crystal grains of certain sizes. The effect under discussion is caused by reflection of this general radiation from the principal atom planes of these crystals. Several experiments, and a geometrical analysis of the positions and orientations of the diffraction effects, confirm this conclusion.

[9] J. O. S. A. and R. S. I. 9, 123-7 (August, 1924)

Notes on Recent Occurrences

PAN-AMERICAN RADIO CONVENTION

AT the Inter-American Conference on Electrical Communications held recently in Mexico City, the Bell System was informally represented by Vice President E. S. Wilson, Lloyd Espenschied and E. S. Hawley, of the American Telephone and Telegraph Company.

The Conference was called for the purpose of discussing means and methods for the future development and improvement of electrical communications between the Pan-American countries. The Conference opened on May 27th with a formal welcome by President Obregon and continued in session until the latter part of July. Delegates were sent by fifteen governments, including Mexico and the United States, who met as an Inter-American Committee to study the situation and report their conclusions to the governing board of the Pan-American Union.

The official delegates of the United States were Hon. Charles B. Warren, then United States Ambassador to Mexico, Hon. Wallace H. White, Congressman from Maine, and Hon. Allen H. Babcock, Member of American Institute of Electrical Engineers, assisted by a technical staff consisting of Mr. William R. Vallance of the State Department, Lt. Commander F. A. Zeusler, Coast Guard for the Treasury Department, Major J. O. Mauborgne and Major L. B. Bender of the War Department, Commander D. C. Bingham and Lieutenant A. H. Tawresey of the Navy Department, Mr. P. E. D. Nagle of the Department of Commerce, and Mr. L. L. Lee of the Shipping Board.

The presence of the Bell System's representatives in an unofficial capacity was the result of inquiries from various governmental sources requesting the views of the Bell System with reference to subjects proposed for

discussion. These representatives were able to lend material assistance by placing at the disposal of the government's technical advisers information based upon the actual operating experience of the companies.

The United States Government, through its delegates, submitted a complete draft of a Radio Convention dealing with safety of navigation, protection of life at sea, and other matters brought into prominence by the rapid growth of modern scientific knowledge and far-reaching progress in the field of wireless communication in recent years. Numerous other proposals were submitted for discussion, including the proposed creation of a Pan-American Central Bureau for the gathering and distribution of information relating to Inter-American Electrical Communications.

The delegates representing the United States Government recommended the encouragement of private initiative and investment of capital under proper safeguards as the best and most practicable means of extending and developing facilities for Pan-American communications, and stated that their government favored private ownership and operation of electrical communication facilities, subject to just governmental regulation without undue interference with the rights of management. Other delegates were inclined to favor government ownership and operation, under conditions prevailing at present in their countries.

No final action was taken at the Conference, but the findings and conclusions of the delegates will be submitted to the Pan-American Union for further consideration by the respective governments of the many important questions that are involved.

THE BELL SYSTEM EDUCATIONAL CONFERENCE

AN educational conference of faculty members from the electrical engineering departments of nineteen of the leading technical institutions in the country meeting

with representatives of the Bell System was held at 195 Broadway during the week of August 18-23, 1924. The purpose of the Conference was to determine ways and means whereby the Bell System could more closely co-operate with the engineering schools of the country and to bring about a common understanding of our mutual problems. The visiting members were invited to submit suggestions as to the manner in which the Bell System could contribute toward the development of electrical engineering courses.

The program consisted of morning sessions devoted to papers and discussions while the afternoons were spent in observation trips to the Bell System laboratories, local and long distance installations at the Walker Street building, and also in the demonstration of the telephone apparatus which is to be presented this fall to each of the institutions represented.

During the Conference the large problems of organization and operation of the Bell System were presented by Mr. W. S. Gifford and other officials of the System while the more technical aspects of the business were treated by representative specialists of the organization. Of great interest and value were the full and free discussions of the subjects presented, bringing about a mutual understanding of the best means of co-operation between this industry and the educational institutions. The two outstanding factors of importance whereby the Bell System could contribute to the development of electrical engineering courses were the aid to the laboratories through the gift of apparatus and a distribution of technical data for instructional purposes, and every effort is now being made to meet these requirements.

THE TELEPHONE'S PART IN DEFENSE TEST DAY

THAT America's electrical communication facilities, and particularly its nation-wide telephone system, are constantly prepared to meet any demand for service

was demonstrated on the evening of September 12, when 38,000 miles of Bell System wire were placed at the disposal of the War Department as a part of the Defense Test Day program.

This network of circuits connected the headquarters of Army Corps Areas in San Francisco, Omaha, Chicago and New York direct with Washington, where General John J. Pershing and a distinguished company of army officers and government officials listened to reports of the generals commanding these areas as to the results of day's activities.

These reports and a number of addresses which were made at Washington were heard by a vast radio audience through eighteen widely scattered broadcasting stations which had been connected with the circuit. This was the most widespread combination of wires and broadcasting stations thus far recorded, the stations extending from Boston to San Francisco and from Minneapolis to Atlanta and Dallas.

It was significantly pointed out by Brigadier General John J. Carty of the Officers' Reserve Corps, who had charge of the communication features of the test, that while these stations were connected with the wires, for the purposes of the test, so that the radio listeners might hear the conversations taking place over them, this would not be the case in the event of an actual national emergency, when the messages would reach only the individuals for whom they were intended.

The speakers at Washington were Major General Charles M. Saltzman, Chief Signal Officer of the United States Army, who presided; Hon. John W. Weeks, Secretary of War; General Pershing and General Carty. General Hugh A. Drum, head of the General Staff Committee on Defense Test Day, made a brief announcement in regard to the results of the test throughout the nation.

Secretary Weeks and General Pershing explained the purpose of the test and outlined some of the benefits which it was believed to have brought about. Both paid

high tribute to the spirit of patriotism, evidenced throughout the nation, which had made the test and the exercises held in connection with it a marked success.

Of particular interest, from the standpoint of electrical communications, were the remarks of General Carty. In pointing out the importance of adequate communication facilities as a part of any successful plan for national defense, he declared that electrical communications are constantly brought into play in meeting everyday emergencies in the home, in the office, in the factory, and on the farm, on the highway and on the street. He showed how doubly important these facilities become when disasters affecting entire communities occur and said that it was fitting that a test of these facilities for electrical communication should be made, to determine their adequacy for the national defense.

After graphically describing the extent of the facilities required to provide nation-wide telephone service, he said: "Employed in this intercommunicating system there have been on duty today throughout the United States 425,000 men and women. From the nature of their everyday employment, these men and women are accustomed to the duties of establishing electrical communication in countless cases of emergency, and in meeting the ordinary demands made upon them they have become well disciplined in performing their functions in serving the public. This Defense Day test has demonstrated that they can be depended upon to perform any duty within their power which might devolve upon them under the plan to expand the Signal Corps in case of great national emergency."

General Carty then "called the roll of the continent," receiving immediate answers as, in rapid succession, he called fourteen cities and towns extending from New York to San Francisco. He then called Major General Morton, commanding the Ninth Corps Area, San Francisco; Major General Duncan, commanding the Seventh Corps

Area, Omaha; Major General Hale, commanding the Sixth Corps Area, Chicago; and Major General Bullard, commanding the Second Corps Area, New York.

General Pershing talked briefly with each of these officers, receiving their reports on the success of the test in their respective areas. Particular interest was given to these conversations by reason of the fact that this was General Pershing's last opportunity to speak directly with his fellow officers as their commanding general, as his official retirement as General of the Armies of the United States, because of having reached the age limit, was scheduled for noon of the next day.

Army officers and officials of the War Department were outspoken in their praise of the efficient manner in which the communication features of the test were handled.

Typical of the expressions of appreciation was that of Major General Saltzman, who said to the radio audience:

"The Department desires me to express its appreciation to the American Telephone and Telegraph Company, and its associated Bell Companies, for all that they have done to make this possible tonight. . . . And this is not the first time that the American Telephone and Telegraph Company has rendered great aid to the army on a defense day. The very first day of the World War, this company organized an office of the Signal Corps of our Army. Ten complete battalions of signal troops were recruited from the Bell companies, which were promptly sent to France, and commenced the building of a great communication system for General Pershing's Army."

In a personal letter to President H. B. Thayer, of the American Telephone and Telegraph Company, General Pershing expressed similar appreciation.

ROYALTY VISITS WALKER STREET

THE Long Lines Offices of the American Telephone and Telegraph Company at 24 Walker Street were among the points of interest visited by the Prince of Wales during his recent visit to New York.

After being besieged by curious crowds which lined the curbs and filled the windows of the financial district, which he had just visited, the royal guest seemed impressed by the contrast presented by row upon row of operators busy at their switchboards. In spite of the fact that news of the presence of the heir to the British throne had quickly passed through the building, not a single operator so much as turned her head as the distinguished visitor passed, according to the members of the reception committee, which consisted of representatives of the Plant and Traffic Departments.

The prince appeared keenly interested in the handling of the long distance traffic to and from New York and asked many questions in regard to the number of calls handled, hours of work, rest periods and similar details. He seemed particularly interested in the provisions for the comfort of the operators when off duty and spoke appreciatively of the rest rooms and lunch room.

One feature of the test room that attracted the prince's attention was the mass of wires where they are brought into the frame for distribution. He listened attentively and understandingly to the explanation of the transmission of pictures over telephone wires. A picture which had been transmitted from Cleveland to New York was shown him. Upon learning that it was a portrait of H. B. Thayer, President of the American Telephone and Telegraph Company, he asked if he might have it. When assured that he might keep it he appeared pleased and tucked it into his pocket.

He appeared to be amazed when told that the lunch room is never closed, that forty or fifty thousand calls are handled through the New York Long Lines office every day and that the operating room he had visited was only one of three devoted exclusively to Long Lines traffic.

Organization Changes

American Telephone and Telegraph Company

T. G. Miller appointed General Manager, Long Lines Department.

Entered employment of Bell System in 1904, after graduating from college and working for several years in Construction Department of National Railway of Mexico, his first position being in the Long Lines Department of the American Telephone and Telegraph Company; District Supervisor of Line Maintenance, Atlanta, Ga., 1906-1907; General Offices, New York, 1907-1913; Division Plant Superintendent, Chicago, 1913-1919; Returned to New York when company was put under government control, as Acting General Plant Superintendent; General Plant Manager, 1920; General Manager, Long Lines Department, 1924, effective September 22.

New York Telephone Company

Howard F. Thurber elected Chairman of Board of Directors.

Entered Engineering Department, Metropolitan Telephone and Telegraph Company, the predecessor of the New York Telephone Company, 1890; Assistant Chief Engineer, 1893; General Superintendent, 1894, General Manager, 1906; Vice-President and General Manager, 1908; President, New York Telephone Company, 1919; Resigned as President and made Chairman of Board of Directors, September 24, 1924.

James S. McCulloh elected President.

Entered employment of Bell System in 1893 after being engaged since 1885 in railroad work. With Long Lines Department, American Telephone and Telegraph Company in central office operating and maintenance work, serving as Division Superintendent in various

Middle West and New England territories; transferred to New York Telephone Company, as Superintendent of Buildings and Insurance, 1903; General Contract Agent (title later changed to General Commercial Superintendent) 1908; Vice-President in charge of Commercial Work and Public Relations, 1919; Operating Vice-President, 1923; elected President, September 24, 1924.